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Early Encounters with the History of Surgery

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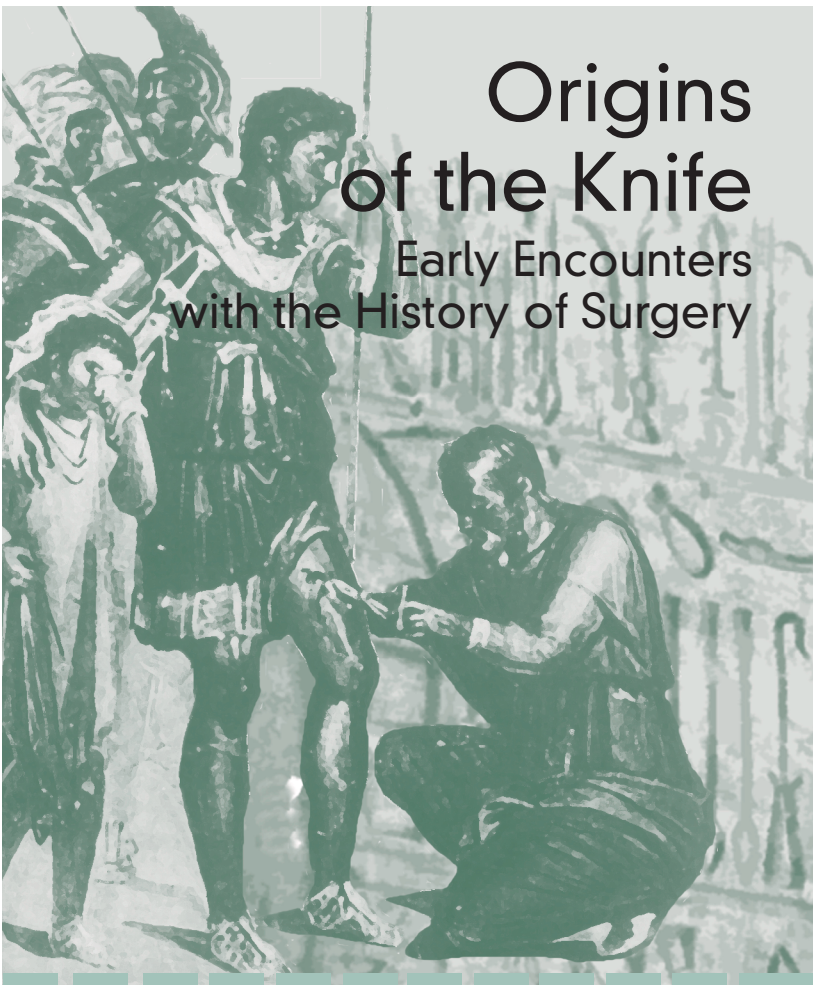

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v a d e m e c u m

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Luis H. Toledo-Pereyra
Michigan State University
Kalamazoo Center for Medical Studies
Borgess Research Institute
Western Michigan University
Kalamazoo, Michigan, U.S.A.

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GEORGETOWN, TEXAS
U.S.A.

VADEMECUM
Origins of the Knife: Early Encounters with the History of Surgery
LANDES BIOSCIENCE
Georgetown, Texas U.S.A.

Printed in the U.S.A.

Please address all inquiries to the Publisher:
Landes Bioscience, 810 South Church Street, Georgetown, Texas 78626, U.S.A.
Phone: 512/ 863 7762; FAX: 512/ 863 0081

ISBN: 1-57059-694-8

Cover artwork by Kristen Shumaker.

Library of Congress Cataloging-in-Publication Data

Toledo-Pereyra, Luis H.
Origins of the knife : early encounters with the history of surgery /
Luis H. Toledo-Pereyra.
p. ; cm. -- (Vademecum)
Includes bibliographical references and index.
ISBN 1-57059-694-8
1. Surgery--History. I. Title. II. Series.
[DNLM: 1. Surgery--history. 2. History, Ancient. WO 11.1
T649o 2006]
RD19.T65 2006
617.09--dc22

2006024440

To Owen H. Wangeensten (1898-1981)
and John S. Najarian (1927-), leaders of the Minnesota Surgical
School for more than half a century, who with dedicated interest
built a scientific surgical tradition beyond compare
and one that is very much worth pursuing.

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About the Author

Luis H. Toledo-Pereyra

Surgeon, Researcher and Educator.
He is the author and editor of 18 books.
His last book, *Vignettes on Surgery, History and Humanities*, has been introduced as the standard textbook for the course of the history of medicine at Western Michigan University.
He lives in Portage, Michigan.

Preface

A Simple Explanation

I had assisted the mature cardiovascular surgeon in his prolonged and complicated case. This time, unlike most others, the patient had not returned to the recovery room. Though success in a three-day-old child with multiple congenital heart defects, including arterial transposition, was unheard of in 1970, the accomplished technician took his lack of success personally. He suffered with the patient and was reluctant to accept a poor outcome. As the small, sheet-covered body was carried out, the surgeon prepared to explain to the anxious parents the fate of the child.

The scene was an emotional one—parents, family and surgeon were all overwhelmed by the circumstances. They couldn't accept that in a time of such technological advancement, the results could be so disappointing. Although seldom faced today, such a distressing situation was frequently confronted in our past. Today, surgeons and patients are accustomed to success, not realizing that centuries of accumulated experience and history have given us our trust in the surgeon's ability to open and repair our bodies.

In this book, I trace the *Origins of the Knife*, searching for the early encounters with the history of surgery. I review the most important surgical events and analyze the role of man, society, and medicine in the creation of the temple of surgery. The knife directs the story of surgery, as it matures from a blunt and erratic stone to a steady—but not sterile—scalpel. With the knife as our guide, we explore the influences of religion and culture, as well as the creation of anatomical and physiological principles, throughout the development of surgery. I also attempt to penetrate the minds and personalities of the men and women who have dared to use the knife to invade the body for exploration and repair.

My intention is to reach and stimulate the intellectual curiosity of lay readers. I do not attempt to satisfy the academic ambition of the historian, as others before me have brilliantly assumed that responsibility. There is no reason to repeat those works. My objective is to tell a simple, engaging and invigorating story of the beginnings of surgery. I hope to inform and educate those who have had little exposure to our surgical ancestors and their accomplishments.

Many misconceptions were constructed and fortified in primitive times when spiritual mysticism and heroism dominated surgery. It was not until accumulated knowledge brought a more rational approach that surgery moved from an empirical discipline to one with a scientific basis. Established and documented methods slowly replaced trial-and-error as the basis for surgical advancement. This process was accelerated as the knife moved from the wise yet surgically naive hand of the unprepared shaman to the disciplined hand of the secularly inclined surgeon. As scientific knowledge grew in the eighteenth century, surgeons increasingly preferred to use facts and logic in combating illness. By the late nineteenth century, the barber-surgeon of the Middle Ages had evolved into an educated physician, treating patients safely while alleviating their pain.

In this account, I concentrate on the *Origins of the Knife* from primitive times to the end of the Roman Empire. Further excursions into other times, such as the Middle Ages, Renaissance, and subsequent periods, must be left for other books describing the history of the knife.

My story is one of events and personalities, as well as conquests and failures in securing the temple of surgery. The knife is offered as a means of entering this sacred temple and participating in healing and discovery. Our story will take you through the magnificent creations of our surgical forefathers, who constantly risked social condemnation, physical peril, and the agony of failure. Throughout the millennia of our tale, we must admire the courage and unconditional trust of countless patients whose sacrifices enabled surgeons to build that magnificent temple.

Luis H. Toledo-Pereyra

Justification

Miguel de Cervantes (1547-1616), extraordinary Spanish literary genius, author of *Don Quixote*, and acclaimed all the world over, recognized with humility the impossibility of contravening the laws of nature, in that, "every creature procreates its own resemblance: what therefore could be engendered in my barren, ill-cultivated genius, but a dry, meager offspring, wayward, capricious and full of whimsical motions…" (*Don Quixote* translated into English by Tobias Smollet, The Modern Library, New York, 2004). With many more loads of justification, I wholeheartedly support the rationale and understanding of the Spanish master and hope that this very humble work, but the only one I could produce, will bring to the interested reader a new perspective in the knowledge of surgery of antiquity, the knowledge of the *Origins of the Knife*.

Acknowledgments

For fourteen years, I worked from time to time on this book. Many people helped me in shaping the literary ways of expressing my story, particularly my son, Alexander Horacio Toledo, currently a surgeon in the making at the University of Maryland and Northwestern University, who spent countless hours in correcting my errors and advising me on improved means to tell a better narrative. Sarah Staples, English Advisor, continued the correction of the manuscript for style and syntax. Whatever this book offers in preserved literary value is their doing, and whatever fault is found is my responsibility. Thank you both for your help.

CHAPTER 1

Personal Reflections

The Life of the Knife

Surgery has different meanings to different people. For the specialist, it is a scientific and technological profession. For the world of medicine, it is a pragmatic field of knowledge that requires practical and theoretical learning, and for patients, it carries an aura of sophistication and unknown certainty. It is, in essence, the life of the knife.

Why does surgery have such an effect on us? Why is it so mysterious, unknown and overwhelming? The mystery probably relates to the lack of control that one has while under anesthesia, and therefore, the lack of direct participation during the great event, even though the patient is the most important part of surgery.

At any moment, we might face the prospect of surgery for ourselves, our families, or our acquaintances. The outcome of surgery varies in quality and proportion. Surgery is something that, as human beings, we do not look forward to….something to which we'd like to be minimally exposed. With surgery comes the feeling we are not in control and the results are not completely predictable. The feeling is like confronting our creator soul to soul—not an easy feeling to recognize, to tame, or to understand!

Nothing seems to prepare us for surgery without fear. Even consolation cannot leave our spirits unshaken. Perhaps improved technology, even better results, and more sensitive approach to patient education and care will allow us to control that feeling.

We are living in a special time in the development of the knife, in understanding the life of this instrument. The degree of expertise, which has been accrued in all fields of surgery, is remarkable. The heart is not only repaired but turned upside down and replaced when needed. The liver also can be repaired, removed and replaced. Most of the organs, vital in nature, are readily dispensed. Years of study, research, and imaginative thinking have brought great advances in the surgical arena. Patients can have surgery and leave the hospital

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the same day. With confidence in modern methods, patients are able to select their own care and plan their treatments more effectively.

But surgery goes beyond surgical act, representing instead a meld of mastery, art, science and technology. Surgery confronts life and death. Surgery is humanism. To understand surgery, one has to believe in the act, the mystery, the mastery, and above all else, the patient. Surgery is something so special that it requires years of meticulous preparation to master the understanding and practice of it. Surgery of antiquity, as primitive as it might appear, was the engine that generated the whole modern surgical enterprise.[1-10]

The knife has a life of its own that can generate healing and comfort. The knife is strong and committed to saving lives. The knife can offer cure at any time on its voyage. The knife is the director of the surgeon's dreams and accomplishments.

It is our obligation to find the primitive users of this bold and courageous instrument, the knife. In this book, we encounter the early humans who gave the first steps to define the nature of the knife, and as important, we characterize their presence, motives, and successful results. We welcome the knife in its most primitive and advanced forms.

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CHAPTER 2

Primitive Times

The First Traces of the Knife

> *"Speaking of primitive surgery is one of those arbitrary procedures which are to a certain extent unavoidable if we try to analyze primitive phenomena for a better understanding of our own cultural processes, and which are justifiable as long as we remain aware of their arbitrary character."*
>
> —Erwin H. Ackerkneckt
> *Amer Anthrop* 1947; 49:25

My resting hands trembled slightly at the completion of surgery. Perspiration saturated my scrubs as if I had just completed a grueling workout. I leaned back into the plush sofa and contemplated in my own mind the kidney-pancreas transplant I had struggled with for more than five hours. This was a unique case I had encountered in my surgical transplant practice at Detroit's Mount Carmel Mercy Hospital in the mid 1980s. Organs and tissues had to be moved and manipulated to fit the large, healthy kidney into the recipient's frail body. A reconstruction was needed to restore circulation after a blockage developed in one of the vessels. At several fleeting moments, it appeared that all my surgical training did not prepare me for the eventualities encountered in this case. I worried about the trauma imposed upon the transplanted kidney, especially after the unavoidable complications of a swollen pancreas and the bleeding vessels surrounding the gland. Only frequent transfusions could compensate for the voluminous blood loss. In my own solitude, I could not predict urinary and pancreatic leaks. My exhausted body relaxed into the sofa while my mind remained preoccupied with my profession.

In spite of the future challenges, I was still confident that the patient would recover by week's end. Nonetheless, I could imagine how the scenario may have differed just a few short decades ago. As I traveled backward in time, I recalled the unusual feeling of disease

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dominating science, environment controlling behavior, scarcity taming desire. Even had I performed a flawless surgery with extraordinary skill and precision, losing the patient would remain a frustrating reality. With nothing but the soft hum of the air conditioner to distract my journey, I followed my curiosity into the most primitive of times. I wondered how and why our prehistoric ancestors performed trephinations, where pieces of skull were removed. I thought of a time before science and reason when surgery was governed by magic and competing spirits, an era when surgery was stripped of all technology. Equipped only with a stone knife and some magical herbs, the primitive surgeon was isolated in his struggle. The conflict was simple but fierce: nature against courage, man against disease, one spirit against another, abundant pathology against absent knowledge.

Surprisingly enough, our earliest primitive ancestors mark the very beginnings of this story of the knife. Our oldest progenitor, the *Australopithecus*, a creature barely distinguishable from other animals, was likely capable of little more than killing and reproducing. This creature, which lived over 2,500,000 years ago, was initially found in Eastern and Southern Africa. It evolved into the Homo species *Homo habilis* first during the **Paleolithic Period** (Old Stone Age), which lasted from 3,000,000 to 10,000 B.C. Survival via hunting and gathering was the primary goal of this primitive man, who probably had no medical motivation beyond licking his own wounds. Man's surgical roots could possibly be traced back to the time between 1,500,000 B.C. and 300,000 B.C. when *Homo erectus* (early primitive human beings) evolved. This prehistoric people developed the use of stone tools and hand axes. However, these instruments were probably used for chopping, building shelters, and fighting, as opposed to performing any primitive surgical procedures.

By 300,000 B.C., early fossil records obtained in 1856 from Germany's Neander Valley showed the first signs of *Homo sapiens* (later primitive human beings). For them, as for their ancestors, hunting continued to be the main means of survival as they learned how to make and control fire. Physical increases in height and brain size, as well as the performance of daily activities separated the *Australopithecus* from the *Homo sapiens*. While these changes in man's lifestyle and activities indicated an increased level of skill, it is unknown whether surgery was among his emerging capabilities.

Without any writings from this age, we are left with more questions than answers as time, natural elements, and human settlements have destroyed many of the remaining clues (Fig. 2.1). **Prehistory**,

Figure 2.1. First evidence registered of a wounded bison in prehistoric times encountered in the caves at Lascaux, France. See the small intestines coming out near the posterior extremities, circa 15,000 B.C.E. (Reproduced from Lyons AS, Petrucelli II RJ. *Medicine: An Illustrated History*. New York: Harry N. Abrams Inc., 1978.)

this long period before the advent of writing, lasted until approximately 3,000 B.C. With only a few artifacts, fossils, bones, and the scant remains of some buildings and weapons, archeologists have struggled to reconstruct life into this unknown era. Unraveling the details of **prehistoric** human life, building theories, and developing conclusions have all been complicated tasks for paleoanthropologists dealing with the origins of man.

Scientists have been able to determine the age of some objects using the radioactive isotope carbon-14. ^{14}C can date organic matter as far back as 40,000 years. For those rare objects that date back even further, amino acid racemization remains the preferred method allowing researchers to trace objects as far back as a few million years. Archeologists have also utilized the potassium argon technique for estimating the age of volcanic rock and the objects preserved in it. By employing a combination of a variety of tests, archeological experts have been able to determine man's evolutionary time line and outline various civilizations and skill levels.

2

In 1868, the French anthropologist, Louis Lartet, using these scientific dating techniques and fossils he encountered near Brive, France, identified the next step in human evolution, known as *Homo sapiens sapiens* or Cro-Magnon Man. This subspecies, also recognized as modern human beings, had first appeared during the Paleolithic Period around 90,000 B.C. The *Homo sapiens sapiens* stood more than five-and-one-half feet tall, and their activities included burial of the dead, sewing, cave painting, utilization of flake tools, as well as continued dependence on fishing and hunting.

The dawn of the **New Stone Age** or **Neolithic Period**, around 10,000 B.C. brought with it the replacement of most *Homo sapiens sapiens*, or Cro-Magnon Man with modern human beings. Man began to demonstrate further advances such as the domestication of plants and animals and the production of pottery. However, the most remarkable progression of this period was the development of farming.

It was Neolithic man who first understood the value of agriculture in building a community, and eventually, a civilization and so began a revolutionary change in lifestyle for mankind. The nomadic and predatory movement of populations in pursuit of wild animals gave way to the settled lifestyle required for farming and cultivation (goats, pigs, sheep, and cattle represented the earliest domesticated animals, while the most recognizable prehistoric crops included beans, squash, wheat, bananas, and an assortment of berries).

As farmers inhabited different regions, villages and small communities were established. While it is thought that these communities were initially developed first near Jordan, Israel, and Iran around 9,000 B.C., by 6,500 B.C., this new agricultural lifestyle was independently adopted in Greece, Thailand, and Mexico. Around 6,000 B.C., shortly after this initial rise of agriculture and permanent settlements, the Neolithic man began spreading farming villages throughout southwestern Asia and southeastern Europe. Settlements in central Europe and the northern Nile River Valley followed soon after. By 3,000 B.C., the Indus River Valley in Pakistan, the Hang Ho Valley in northern China, southern Mexico, and South America had all been converted to agriculture.

Maintaining this new agricultural lifestyle required great technological advances, including both revised labor systems and improved tools. These improved tools could have made advanced surgical procedures a reality during Neolithic times. With access to knives and other tools, as well as to fire, Neolithic man could have experimented with alternate means of healing. No longer would

man rely exclusively on licking and dressing his wounds in the crude and primitive art of healing.

Coinciding with the spread of agriculture and its rooted lifestyle was the discovery and use of bronze around 3,000 B.C. The **Bronze Age**, originating in Sumer and Mesopotamia, introduced the use of alloys consisting of arsenic or tin with copper. Most notable of this period, however, was the discovery that the fluidity and malleability of bronze made it a more applicable metal in daily activities. During this time societies emerged as more organized. Expanded trade, transportation, and food production would all be crucial in the advancements of subsequent civilizations. Even with these advances, surgery would follow its unscientific and mysterious heritage.

Anthropologists and historians have tempted us by suggesting that holes were produced in the skulls of living men as early as 10,000 B.C., during the early Neolithic period. The discovery of some healed trephinations, or openings of the skull, indicates that some of the patients must have survived the crude and primitive surgical procedures. While these vague but intriguing findings have fueled our curiosity, even the most elementary questions continue to baffle historians and cause debate.

What injuries were sustained in our ancestor's ceaseless struggle for survival? What were their surgical capabilities? Who performed these primitive procedures? Were the trephinations holistic rituals or secular and routine remedies? What motivations justified these dangerous procedures? How did out first surgeons penetrate the thick walls of the cranium, and how did their patients tolerate the intense pain? Without any written records, we are left only with scattered bone fragments and a few faded cave illustrations in the search for our surgical origins.

This dearth of conclusive findings regarding primitive surgery opens the way for many imaginative conjectures. Perhaps a primitive man suffered from severe, uncontrollable seizures. Close family and kin, concerned with the spiritual sources of his convulsions, took him to their chief religious figure. After analyzing this spiritually afflicted man and consulting various supernatural forces, the shaman deemed the trephination urgent in order to release the demonic forces trapped in his patient's skull. The family then gathered the community for a ceremony to excise the evil spirits. As the community arrived at the traditional site for these events, the people offered their best tools and weapons to the shaman to combat the spirits. The community then backed away from the prone patient, allowing the shaman to proceed with the sacred trephination.

The religious chief secured the head of his possessed patient between two large and fitted rocks. The patient was then given an herbal concoction, a primarily unsuccessful attempt at sedation. However, in this essentially religious affair, the scientific or therapeutic value of the operation was secondary to the spiritual significance of the ritual. The shaman, appealing to the gods who will liberate the victim from the evil spirits, made specific and deliberate movements encircling the victimized body. A short period of concentration is followed by a longer period of incantations and manipulations of the patient's head. Without warning, the religious chief picked up a large and pointed stone and placed it firmly on his patient's skull using a larger and heavier rock as a hammer and an assistant then helped the shaman drive the stake into the skull. The primitive surgeon continued with vigor and intensity. Through his patient's deafening cries and mad screams, the shaman began to sense the expulsion of the demons. Persistently he hammered at the bone until the piece of "corrupted" skull was freed. Hair, skin, bits of bone hung from the bloody wounds. Some of which are neat, while others are jagged and irregular in shape. Regardless of the cosmetics or the patient's health, the community had successfully rid itself of the demon spirits (Table 2.1).

Henry Sigerist, a premier historian of medicine, presented to us an extraordinary analysis of the principles and patterns of primitive medicine. According to him, soul searching, sacred events, healing

Table 2.1. Periods of primitive times and surgical contributions

Periods	Years (B.C.)	Subspecies of Man	Surgical Contributions
Old Stone Age			
Paleolithic	3,000,000–1,500,000	*Australopithecus*	Unknown
	1,500,000–300,000	*Homo erectus*	Unknown
	300,000–90,000	*Homo sapiens*	Unknown
Mesolithic	90,000–10,000	*Homo sapiens sapiens*	Wound dressing, bone setting
New Stone Age			
Neolithic	10,000–3,000	Most advanced *Homo sapiens sapiens* (Modern human beings)	Skull trephination

rites, supernatural forces, and ghost and spirit control were all factors in recognizing and managing disease for primitive people. He considered "purification, propitiation, and supplication of the spirits, as well as sacrifices, prayer, and atonement, as elements of a general ritual, while special measures were required by the specific nature of the disease in question." The transcendental lay hidden behind all medical phenomena, and empirico-rational basis did not exist in practice. It would take thousands of years until the Greeks would develop a rational and etiological system in the practice of medicine.

In addition to explanations of magic and purification, other surgical scenarios likely existed in prehistoric times. Without further evidence, many important aspects, such as primitive man's motivations and his surgical environment, are left to the realm of our educated imagination. Perhaps skull trephinations were routine, performed privately and without ceremony. Maybe friends and family executed this dangerous procedure. Maybe this practice was reserved for cases of severe head trauma, or perhaps surgery did not exist at all in prehistoric times! It must be remembered that primitive man was engaged in a constant struggle for survival. How much thought or effort could primitive man give to surgery while preoccupied with obtaining food, finding shelter, and evading wild animals? It is only by molding indirect findings that we have discovered the origins of surgery (Table 2.2).

Even the evidence of healed fractures is not necessarily indicative of primitive surgery. The same type of healed fractures observed in early humans can also be seen in many of prehistoric man's mammalian contemporaries. The circumstances of their environment, together with primitive man's anatomical and physiological ignorance, severely restrict the possible realm of surgical procedures for our earliest ancestors. Still, our ancestors must have made some attempts to preserve their health, even if their means and motivations were largely magical. The presence of disease and infection is well documented in bone and tooth evidence, and presumably, disease was equally prevalent in soft organs and tissues.

Wounds, limited in depth, as well as damaged tissues, were probably dressed in traditional arrangements of plants, herbs, roots, and animal substances. Perhaps the piercing of boils and blisters or the digging and removal of splinters represented man's earliest encounters with surgery. However, without any anatomical knowledge, early man's use of sharp tools was probably more harmful than helpful. As it would be for millennia, the loss of blood was probably observed

Table 2.2. Reasons for performance of skull trephinations in Neolithic times[1-10]

History Author	Reasons	Country/Continent of Origin
Ackerknecht	Magical-Surgical	Europe, Russia, Africa
Graham	Magical-Religious	France, Western Europe
Knowles	Therapeutic	Western Europe
Lain Entralgo	Therapeutic-Magical	Hungary, Spain, Europe
Magner	Magical-Practical	Peru, Europe, Russia, India
Majno	Magical-Religious-Practical	Europe
Moodie	Unknown	France
Rutkow	Magical-Religious	Western Europe, Asia
Sigerist	Magical-Religious-Practical	France, Poland, Russia, Americas
Steinbock	Magical-Religious	Europe

without interest. With limited evidence, anthropologists have been forced to pursue other avenues in trying to unravel the mystery surrounding the existence and extent of primitive surgery.

Only by drawing parallels with still-primitive cultures in isolated regions of Africa, South America and certain Pacific islands and mountain ranges have anthropologists been able to make some valuable inferences about archaic forms of surgery. Based on conditions in today's most isolated regions, headaches, epilepsy, and skull fractures were probably the primary causes for trephination in ancient times. If today's primitive societies parallel ancient ones, extremely rudimentary attempts at anesthesia with native herbs was the extent of patient sedation in ancient times. In northern Africa near Egypt, a crude form of opium was used to sedate patients, while palm alcohol was preferred in Uganda and Central Africa. Surgical instruments in this area were often made of animal bone, but this practice also varied greatly by geographic location. For example, in the South Pacific islands, sharpened coconut shells were used to perform trephinations. Based on some of today's primitive procedures in this region, it is likely that coconut shells were also used to replace missing skull fragments following surgery. Regardless of location, the native customs of primitive societies offered both spiritual and therapeutic value to the patient.

Erwin Ackerkneckt, the world's foremost scholar in primitive surgery, gives a full account of the practice of skull trephining by contemporary tribes or nations comparing it to that of primitive societies in the world. Abyssinia, Uganda, Nigeria and Daghestan

represented some of them. In Oceania, this practice grained increased popularity in New Caledonia, New Zealand, New Guinea, Uvea, Loyalty Islands, the Gazelle Peninsula, New Ireland, New Britain, The Solomon Islands and Tahiti. Trephination was also practiced in the Americas, from Canada to South America, with Peru being the most active place.

Similar to today's most primitive cultures, in ancient times, the supernatural was believed to play a principal role in the healing process. Often, physical diagnosis and symptoms, such as headaches and seizures, were thought to have spiritual origins and explanations. For this reason, magic men, sorcerers, and shamans were the well-esteemed combatants of the evil spirits. Despite their determination to eradicate demon spirits, these religious leaders lacked the means to perform surgery until the advent of weapons and tools in the Neolithic Age, between 10,000 B.C. and 3,500 B.C. Prior to the advent of these tools, primitive man did little more than lick his wounds, remove splinters, or sometimes decompress abscesses.

As man's skill in developing weapons and tools from natural materials increased, surgery became a more feasible option in combating the spirits. The most common surgical techniques for trephination were the hammer-and-chisel method, the circular grooving technique, and the persistent scraping or drilling of the tissue and bone. The most advanced method, the boring-and-cutting technique, incorporated both the drilling and chiseling methods. After several small holes were created with a sharp drilling instrument, the hammer-and-chisel technique was employed to connect the perforations. When the piece of liberated skull was removed, the wound was dressed with grass and leaves. Typically, the crude instruments used to open the cranium in these procedures were made of stones, flints, microlith, quartz, or levallois flakes.

Our surgical origins remain mired in obscurity until the rise of the Inca empire, the time of the first accountable and well-documented surgical acts. (Inca medicine, however, did not flourish in primitive times (≤3,000 B.C.). Other Andean Indians, before the Incas, must have performed these great surgical feats. Near the tombs of Paracus, Peru, archeologists have located numerous skulls with holes that appear to have been produced before death, as evidenced by new bone formation surrounding the incision. Additionally, the caves of Paracus have yielded many chisels, obsidian spear-tips and other instruments of copper, silver, and gold alloys indicative of ancient trephinations. The Incas favored the parietal area of the skull for trephination. Most

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Table 2.3. First reports of skull trephination from early times[1-10]

History Author	Reported By	Year of Report	Site of Discovery
Lain Entralgo	Kovacs	1853	Hungary
Steinbock	Squier	1873	Peru
Sigerist	Pruniéres	1873	France
	Broca	1876	Peru
Knowles	Broca	1876	Peru

likely, this region was not chosen for scientific reasons, but rather for the convenience of the surgeon, who would squat in front of or behind the patient while holding the patient's head firmly between his knees. A skull fracture was a prevalent cause for trephination in Incan society. However, intense headaches, debilitating diseases, head wounds, and other trauma also provided impetus for trephination. When Incan trephinations were performed, other important preparations accompanied by actual surgery (Table 2.3).

Essential to the Incas' surgical success were their surprisingly effective anesthetics and post-surgery treatments. Coca plants, readily available throughout most of the Inca Empire, were used to sedate the patients. Other plants and herbs high in alcohol were also used as anesthetics. Although these extracts did not completely anesthetize the patients, they were effective in significantly blocking the intense pain generated from trephinations. These remedies, when combined with our ancestors' superior threshold of pain, were probably adequate in allowing for short and uncomplicated surgical procedures. Following surgery, the Incas were able to accelerate the healing process by employing the extracts of certain roots and small plants prevalent in their Empire. Considering their patients' relatively low infection rate, it is not surprising that these Incan remedies were high in tannic acid, an anti-bacterial whose derivatives are still found in some medicines today.

The Incas' highly evolved surgical and medical practices manifested themselves in an astonishing sixty percent trephination survival rate. Imagine, with such primitive instruments and surgical techniques, the Incan's trephinated patient was almost as likely to survive as he was to fall victim to the surgeon and his imperfect procedure. Considering the lack of anatomical knowledge and the highly unsterile surgical conditions, this survival rate was quite impressive.

In some cases, primitive skulls actually showed evidence of multiple successful trephinations. As time would tell, it would be many civilizations and dozens of centuries before these results would be equaled. Many eighteenth and early nineteenth century surgeons and historians, in light of the erratic surgical results of their own epoch, refused to believe this anthropological data. Considering our lack of knowledge regarding many of the other aspects of primitive surgery, it is only fitting that the success of primitive man's surgical endeavors leaves us equally perplexed and bewildered. It appears that without further findings, the essence of the surgeries performed at the dawn of civilization will remain shrouded in mystery (Table 2.4).

Another key element in the advancement of mankind was the transition from bronze to iron around 1,500 B.C. Iron was more abundant, more durable, and more efficient to process. The increased use of iron made it possible to construct larger cities, allowing for more human contact. During the **Iron Age**, sophisticated trading objects, advanced cultivation of grain, and improved animal utilization for commercial and domestic purposes also contributed to improved health and living standards. While we can trace our social, technological, and physical roots from the *Australopithecus* and *Homo erectus* to the modern human beings of the Iron Age, the same cannot be said of our surgical lineage.

In conclusion, magic and religious beliefs during primitive times dominated the existence of surgical events. Sick individuals were

Table 2.4. Contributions of primitive surgeons[1-10]

Type of Procedure	Evidence
Bonesetting (fracture alignment and dislocation management)	Direct
Trephination of skull	Direct
Amputation of fingers and other body parts (perhaps as punishment)	Direct
Incisions—opening boils and abscesses	Indirect*
Bleeding control—cauterization	Indirect*
Wound treatment—dressings	Indirect*
Bloodletting—scarification	Indirect*

*Direct evidence means evidence encountered through fossils or other expressions of art. Indirect evidence means extrapolation from primitive societies existing today or logical deductions from other findings.

believed to be possessed by demons and cure was only reached by releasing these demons from their victims. These unscientific happenings represented the basis of primitive developments and, therefore, the origins of surgery in primitive ages. Primitive surgery was magical and religious and not based on rationally established therapeutic methods.

One week after the kidney-pancreas transplant operation, I was clearly satisfied with the progress of the patient, who had been transferred from Intensive Care to the regular floor and was receiving a near normal diet. Both organs, kidney and pancreas, had recovered normal function, and initial success could be predicted. The wonders of 21st Century scientific surgery remained in my own mind, inexplicable and of enormous significance as compared with the surgical capabilities of our early ancestors. The initial questions I had, of the why's and what's of surgery of primitive times had not been answered, yet their importance had not diminished in spite of lack of information and imprecise sources. I realized that students of primitive cultures would have to content themselves with isolated pieces of poorly understood data.

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CHAPTER 3

Mesopotamia—The Fertile Crescent

Attempts at Controlling the Knife: The Hammurabi Code

> *"We know that surgery was practiced at an early date in Mesopotamia, since the Code of Hammurabi dealt with the surgeon's liability. It is also perfectly obvious that the armies had surgeons who knew how to treat wounds. Patients must have been bled here as everywhere else in antiquity, either through phlebotomy or cupping. Yet since we do not possess a single surgical text we know nothing about Babylonian and Assyrian surgery. This in itself is not astonishing because surgery is not learned from books, as we mentioned in the case of Egypt. Yet we would expect to have texts dealing with the treatment of wounds, abscesses, tumors and other surgical diseases. It is very possible that further excavations will bring such texts to light."*
>
> —Henry E. Sigerist
> *A History of Medicine* 1967:490

The progressive nature of the large brain stem tumor had not deterred the indomitable fighting spirit of the young child, his parents or the determined pediatric neurosurgeon. Seven-year-old Matthew Anderson of Redford, Michigan and his parents, Alan and Robin, had exhausted all possible medical options. Doctors at Detroit's Children's Hospital and Ann Arbor's University of Michigan Medical Center were all advising against surgery.

Matthew's only hope lay in locating the surgeon of *Gifted Hands*, the book that Alan had just finished reading, the autobiographical account of Ben Carson, Chief Pediatric Neurosurgeon at Johns

Origins of the Knife: Early Encounters with the History of Surgery,
edited by Luis Horacio Toledo-Pereyra. ©2006 Landes Bioscience.

Hopkins. This autobiography had "convinced Anderson that Carson was the one—the only one—with the skill and moxie to save his son."

After innumerable arrangements, the Andersons arrived in Baltimore to meet with Carson in January, 1993. By the end of the month, the courageous surgeon had removed half of Matthew's tumor in an 11-hour operation. "He hoped to beat this tumor back without hurting the patient. He believed that after tumors like Matthew's were trimmed surgically, the immune system could dispose of the rest."

The operation had been successful, and the patient, family, and doctor were elated with the results. However, complete success had not yet been reached. Frequent check-ups of Matthew's brain with MRI scans were to be the hallmark of his progress. Yet at this point, everyone remained cautiously optimistic! It is amazing how surgery and technology had advanced to the degree of sophistication that could help patients like Matthew. Our early Mesopotamian surgical ancestors could not even fathom these medical miracles, which were to be realized with the mastering of current surgical techniques.

Between the rivers Tigris and Euphrates, in the region of Mesopotamia now known as southeastern Iraq, one of the more exceptional cultures of our civilization emerged. Great temples and splendid buildings that once caught the attention of the entire world have all disappeared from the great ancient city of Babylon in the kingdom of Babylonia, leaving only ruins. Not long ago, in 1990, international forces led by the United States military bombed some of the region's historical ruins. When Hussein's troops retreated from occupied Kuwait, they left behind even less to remind the world of the culture's ancient superiority. On March 20, 2003, the United States and supporting allies once more bombed Iraq, enhancing therefore the possibility of more destruction in these historical sites.

These events became a source of such despair to the people and destruction to the land, that citizens of this ancient city would have predicted the displeasure of Ishtar and other Babylonian gods. It was this perception and interpretation of their gods that influenced everything in ancient Babylonian culture, including the practices of healing (Fig. 3.1).

The Mesopotamian culture began in 5,000 B.C. during the Ubaid Period, when agriculture flourished. A millennium later, the Uruk Period saw the development of monumental architecture. The Sumerians, who lived in Babylonia in 3,000 B.C., introduced writing to western civilization. From picture-like symbols scratched on

Figure 3.1. The Code of Hammurabi at the Louvre Museum in Paris. (Reproduced from Ellis H. *A History of Surgery*. London: Greenwich Medical Media, 2001.)

lumps of clay, they preserved literary, religious, economic, and scientific concepts of their day in this cuneiform writing.

The life of Mesopotamia continued, and following the Sumerians, the effects of Semitic, Amorite, Babylonian, and Asirian influences remained alive until the fall of Babylonia in 539 B.C. First Persians, and then later Greeks dominated Mesopotamian life with

Table 3.1. Periods of Mesopotamian culture

Time of Initiation (B.C.)	Periods of Development	Important Events
5000	Ubaid Period	Agriculture
4000	Uruk Period	Towns and monumental architecture
3000	Sumerians	City-state and writing
2500	Akkad-Ur Empire	First Semitic, arts flourished
2000	Old Babylonia	Amorite influence Golden age of science Hammurabi Code of Laws
1400	Asirian Empire	No significant advances
604	Neo-Babylonian Empire	Prosperity under Nebuchadnezzar II
539	Persian and Greek domination	Babylonia fell Assimilation of Mesopotamian culture

the consequent assimilation of culture. The once Fertile Crescent, the cradle of civilization, (modern Iran, Iraq, Syria, Lebanon and Israel) had disappeared with no hope of return.

Samuel Noah Kramer, in his time the foremost Sumerologist in the United States, in 1956 described 27 firsts in man's civilization in his notable book, *History Begins at Sumer*. He presented evidence that Sumerians introduced the beginnings of our culture in more than one way. Their achievements reached the major fields of human endeavor: government, politics, education, literature, philosophy, law, agriculture, and medicine. With dedicated labor, he discovered, read, and translated thousands of cuneiform fragments. The University Museum of Philadelphia, the Ancient Orient Museum at Istanbul, and other well-known museums are now the depository for these writings, initially excavated between 1889 and 1900 at Nippur, an ancient Sumerian site close to Bagdad.

Babylonian society was simple, consisting of three main classes: the *aristocrats* (government, priests, landowners and traders), the *common people* (craft workers, clerics and farmers) and the *slaves*. Fertile lands surrounding the two main rivers were the source of intense and diverse farming. A network of canals carried the water, the use of which was carefully regulated, into the fields. Trade was well developed throughout the region, and exports were taken to all parts of the Middle

East. Wheeled carts and chariots were the means of transportation. In this environment, a successful society flourished, one which would allow significant advancements to appear.

Since Babylonians believed that disease was God's punishment, physicians had to use the power of the spirit and religion controlled healing. Of the three groups of medical professionals in existence, all were associated with priesthood. One group was the Asu, or general physicians, the other group was the *Baru*, or physicians dedicated to diagnosis and prognosis, and the third group was the *Ashipu*, who gave treatments of enchantment or performed magical acts to overcome disease. The *Gallubu* or barbers, who were not truly physicians, were the only ones who had the responsibility of performing minor surgical procedures.

So how did the Babylonian citizen, more than 2500 years ago, seek medical attention? Herodotus, Greek "Father of History," believed that when you got sick in Babylon, you were taken to the main square of the city where people who had known someone with a similar problem would advise you how to remedy your illness. This occurred in the small cities but probably was not the usual medical approach in larger cities, since the physicians were more clearly divided into the three separate groups. Patients sought help directly and knew where to find the priests and physicians.

Surgical matters were quite different since barbers were the only surgeons of the times and treated only minor wounds. There were no standard procedures for surgery as we know it today. There were no routine surgeries, as there were no medical schools, no books that taught the art of surgery, and no collections of case histories or data to give evidence of successful outcomes. Babylonians did, however, have a strong sense of medical ethics. Patients were protected from the harm caused by a barber surgeon's actions long before many other treatments were established.

The Babylonian medical doctor used ceremonious treatments that worked on a spiritual and religious plane, and therefore these magician-doctors enjoyed an elevated social status in spite of poor outcomes. Unfortunately, barber surgeons who worked with their hands rather than powerful spirits had to accept a far inferior status. This poor reputation consistently plagued surgeons until the seventeenth century.

In Mesopotamia, barber-surgeons were treated like all other craftsmen of the time, not as physicians. While religious physicians were revered both in success and failure, the barber-surgeons were not easily pardoned for unsuccessful treatments. In fact, the Hammurabi

3

Table 3.2. Important Mesopotamian rulers through all periods of ancient history

Ruler	Dynasty or Kingdom	Approximate Time (B.C.)
Sargon	Akkad	2300
Ur-Nammu	Ur	2100
Hammurabi	Babylonia	1700
Nebuchadnezzar I	Asirian (Isin)	1100
Assurbanipal	Asirian (Mixed)	668
Nebuchadnezzar II	Neo-Babylonian (Chaldean)	600
Cyrus II	Persian	539
Alexander III	Macedonian (Greek)	331

Code, named after the Babylonian king who governed in the 1700s B.C., had few legal ramifications for a physician's unsuccessful practice, but many serious penalties for the ancient barber-surgeon. Severing a hand was not an uncommon punishment for the unsuccessful treatment of an eye lesion, for example. With consequences such as these it is not surprising that many potential surgeons opted for other kinds of healing, including witchcraft. While the Code of Hammurabi affected most of Mesopotamian society favorably, its severe punishment of surgeons restricted their creativity and confidence, thus limiting the accumulation of knowledge.

History tells us that Babylonians were the first to use law to regulate medicine. Excavations at Susa, Iran in 1901 encountered large fragments of black diorite—seven-feet tall—that demonstrated the details of these laws. According to these artifacts, King Hammurabi received directions from Shamash, the Babylonian sun god and god of justice, to write the laws encompassed in the famous code. Of the 282 laws referring to society, industry, family, and medicine, nine of them were totally associated with medical practice, particularly surgery.

The Code of Hammurabi which once resided in Babylonia in the Temple of Marduck, was moved to the Elamite capital of Susa by victorious Elamite forces about 1200 B.C. French archeologists discovered its existence and carried it to the Louvre. There, it remains as effective proof of the level reached by our ancient medical forefathers.

In searching for the influence of the Code of Hammurabi, which is at the center of the main contribution of Mesopotamians to western surgery, and in understanding its significance, one would have to follow the actual description of those laws that pertain to surgery, numbers 215 to 223:

215 If a physician performed a major operation on a Lord with a bronze lancet and has saved the Lord's life, or he opened up the eye-socket of a Lord with a bronze lancet and has saved the Lord's eye, he shall receive ten shekels of silver.

216 If it was a member of the commonalty, he shall receive five shekels.

217 If it was a Lord's slave, the owner of the slave shall give two shekels of silver to the physician.

218 If a physician performed a major operation on the Lord with a bronze lancet and has caused the Lord's death, or he opened the eye-socket (*nakkaptu*) of a Lord and has destroyed the Lord's eye, they shall cut off his hand.

219 If a physician performed a major operation on a commoner's slave with a bronze lancet and caused (his) death, he shall make good slave for slave.

220 If he opened up his eye-socket (*nakkaptu*) with a bronze lancet and has destroyed his eye, he shall pay one half of his value in silver.

221 If a physician has set a Lord's broken bone, or has healed a sprained tendon, the patient [lit. "*owner of the injury*"] shall give five shekels of silver to the physician.

222 If it was a member of the commonalty, he shall give three shekels of silver.

223 If it was a Lord's slave, the owner of the slave shall give two shekels of silver to the physician.

It is evident, from these writings, that no actual description of any surgical procedure was introduced by the Mesopotamians in the Code of Hammurabi. Penalties were given for operations performed upon the eye and for the treatment of broken bones or sprained tendons. Also indicated was a "major operation" without comment as to its type or nature. With no formal description, any particular kind of operation cannot be assumed. More information regarding Mesopotamian surgical practices must be sought from other, yet-to-be-discovered sources.

It appears that the use of the knife was the determinant factor for the punishment given. Purely medical therapy was not included in the Code of Hammurabi. It could be argued that Mesopotamians had more respect for the physicians than surgeons (users of the knife), who were castigated for any misuse of their instrument. On the other hand, it is necessary to consider that minimal attention was given to

non-surgical therapy since it did not influence the course of the disease and was an ineffective treatment. Thus physicians did not require any penalties. Quite possibly, the immense difference between medical and surgical treatments for Mesopotamians resided in the belief that disease was supernatural and therefore related to divinity, whereas a surgical operation belonged to man and responded to others critical judgement.

Leo Oppenheim, one of the most distinguished Assyriologists of our time, in his extraordinary book *Ancient Mesopotamia: Portrait of a Dead Civilization* (1964), described with great accuracy the state of medicine and its doctors. He recognized two medical traditions within Mesopotamian culture, the scientific and the practical. The first had a large body of tablets, describing "prognostic omens". The second was associated with a series of tablets presenting diagnosis, cause of the suffering (mostly magic), and prescriptions listed according to the nature of symptoms.

Oppenheim believed that the patient-physician relationship in Mesopotamia had two key aspects to understanding the medical science of those days. Members of the practical school identified the disease with a list of symptoms and utilized specific treatments for each case. Members of the scientific school had a different approach to patients and disease. Symptoms were considered as "signs" that participated in the outcome of the disease and helped to identify it. The expert Ashipu then could apply the "appropriate magic countermeasures." It appeared that conjurations and rituals were frequent components of the magic acts utilized. Mesopotamians not only believed in magic but also in the application of medications. They had a dual approach to disease therapy.

While the Mesopotamians relied on both medicine and magic, these two means of treatment would be more aptly titled, "primitive first aid and outright sorcery." How Mesopotamian patients reached one practitioner as opposed to the other, we do not know. It is possible that social status was the most important factor in the patients' ability to receive care. Kings and the royal class, for instance, were privileged to both approaches; physicians of the court as well as sorcerers were widely pursued. Cooperation between the sorcerer (Ashipu) and the physician (Asu) was commonplace, as drugs and magic were equally used. Both Ashipu and the Asu had a job to do, and they were similarly members of the same medical profession. However, it was the Ashipu who held social prestige through his accompanying role with the clergy.

Again, we return to Oppenheim to understand that Mesopotamian medicine was typically folk medicine. Their materia medica consisted of native herbs—roots, stems, leaves, mineral substances, fruits, and animal products such as blood, milk, and bones. Without making a profound study of the flora of Iraq today, it is not hard to find evidence of laxatives, diuretics, analgesics, and other substances within their large reservoir of herbs and fruits. Their use was not exactly based on medical need.

Of the vast medical literature encountered in cuneiform writings, which amounted to around one thousand tablets or fragments, the great majority represented medical and not surgical matters. An enormous part of this material was contained in the library of Assurbanipal, the last great king of Assyria (668 B.C.). When Nineveh was destroyed in 612 B.C., the King's archives were buried within the palace and were then rediscovered in 1853. At present, the British Museum contains most of the library tablets recovered. Guido Majno, a dedicated pathologist and student of ancient cultures shows, in *The Healing Hand*, some worries about the maintenance of these tablets outside of their natural habitat. His concern is related to the drying, formation of crystals, and breaking up of these materials that will not allow for adequate reading and translation. This is particularly important because only a small portion of tablets have even been read.

"*The Treatise of Medical Diagnosis and Prognoses*" represents around 3,000 entries on 40 tablets, and in this way is comparable only to the Ebers papyri of the Egyptians. Diseases, prognoses, and remedies are listed. Majno recognizes that "the actual prognostic significance of this work, in the modern sense, is about nil. Its value is more general…the treatise is essentially a handbook of the sorcerer, not a manual of medicine."

We do not find translations of cuneiform tablets that describe well-organized textbooks of medicine. Even the material collected by Thompson, more than 600 tablets of medical nature, only includes prescriptions, and not detailed case studies with symptoms, signs, and origins of disease.

Other sources of Mesopotamian medicine are marginal at best. Recent publications have appeared in cuneiform, but most are poor translations made by amateur Assyriologists, since the cuneiform writing is not as accessible as other western Latin or Saxon languages. Minor changes in one or two words could modify the meaning of the entire portions of the translated material. Good sources then are fundamental in the telling of our story.

The exceptional writings of Majno are valuable in searching for the Mesopotamian word "wound" and understanding its importance in the medicine of the days. Interestingly, Majno did not find the word "wound" to be readily available in the writings of the time. In his estimation, the closest word was "munsu", which meant disease or diseased part, therefore, the idea "wound" had to be inferred. Other words came close to "wound" but a slightly different meaning, such as: cut, blow, bruise, piercing pain, and swelling. Other related words signified "abscess," "pustule," "eczema," and even "sore."

Setting aside the difficulties in translating and understanding the "wound", a famous Sumerian tablet, the world's oldest medical text (written around 2100 B.C.), explains the various techniques used in wound management. Washing, making plasters, and bandaging were utilized by early Mosopotamians, as one of their recommendations indicates:

> *"Pound together: dried wine dregs, juniper and prunes; pour beer on the mixture. Then rub [the diseased part] with oil, and bind on [as a plaster]."*

Another text notes that the damaged area is first washed with beer and hot water:

> *"Pass through a sieve and then knead together: turtle shell, naga-si plant, salt and mustard. Then wash the diseased part with beer of good quality and hot water, and rub with the mixture."*

Mesopotamians also proposed using a mixture of salt and mustard. Then they suggested rubbing the area and making a plaster to hold it together.

> *"Take some river sediment, pound it, knead it with water; then rub the diseased part with mineral oil, and bind on as a plaster."*

Majno believed that the first rubbing with the above constituents was meant to cause stinging, and the patient probably associated stinging with effectiveness. The use of a plaster or clay (sometimes including egg white and chicken feathers) to treat the wound, even now, appears to be present in certain areas of Iraq.

Medical instrumentation was not a high priority for the Mesopotamians. Spatulas, metal tubes, and lancets appeared to have been used by our early predecessors. The lancet, also called the

"barber's knife," was utilized to produce scarification and fontanels. However, other instruments or simple tools are not mentioned in the medical or surgical writings of the times.

Approximately around the age of Assurbanipal, Mesopotamians began to seek new ways for wound treatment, particularly in regards to new substances or materials that could be used at the site of injury. One such substance was sesame oil, whose positive value, according to Majno, was hard to determine when other drugs were being used simultaneously.

In exploring the activity, knowledge and function of the Asu, it is interesting to note that there was no anatomy or physiology in his repertoire. His understanding and knowledge of the organs of the body inclined toward the magical. The liver stored anger, the heart expressed intelligence, the kidneys demonstrated strength, and the brain had no defined function. The essence of the Asu's activity or art resided in offering for each case the right "potion" or "bultu." A combination of herbs and other ingredients were "pounded, covered, and strained" prior to use. They were then applied as ointment, ingested, or inhaled. The amounts were not controlled, and the substances represented the most diverse type of components, including dung of lizard and other animal body products.

In making plasters for wound care, the Asu must have known some advanced technology. The processes of saponification and distillation were readily used and allowed him to produce soaps (with resin, fat, and alkali) and certain "essences" that contained pine, spruce, myrrh, gum of aleppo pine, honey, and fat from the male sheep's kidney. Both of these procedures were previously described in the famous Sumerian medical tablet already mentioned.

The archives of Assurbanipal describe three additional surgical wounds, which Majno puts into perspective. The first was associated with subcostal drainage of an abscess of the liver or pleura, most likely of amebic origin. The second incision referred to the drainage of an abscess under the scalp, described in detail by the ancient scribes:

> *"If the ailment mentioned above is painless, and the very surface of the flesh is intact; if, when you open, [pus squirts out and] keeps flowing: the name of this disease is "little she-fly" [meaning unclear], If the wind has blown onto the patient, it is a case of Pabil-sag [the god]: you can operate it ["you can make a prescription." In other cases the physician is advised not to intervene]. To remove it, attack this disease with the*

point [of the knife. After cutting it open] grind: boiled plaster, salt of ammonia and powder of…[a mineral, possibly belemnite]. Apply all this onto the diseased surface and make a dressing of it. If the disease [has reached] into the bone, cut all around, scrape and remove [that is, scrape off and remove the sick bone].”

The third represented the postoperative care of a wound of the scalp, described in the original writing:

“Wash a fine linen in water, soak it in oil, and put it on the wound. Bray powder of acacia and ammonia salt, and put it on the wound; let the dressing stand for three days. When [you remove it] wash a fine linen in water, soak it in oil, put it on the wound, and knot a bandage over it. Leave the dressing three more days…thus continue the dressing until healing ensues.”

The use of oil by Mesopotamians is of note, since bacteria do not grow in oil. The use of oil for wound treatment must have allowed early surgeons to achieve better healing results more frequently.

Ancient writings not only describe wound care, but also explain a Mesopotamian doctor’s general approach to inflammation or infection. It appears that for a collection of pus, incision and drainage was the recommended treatment; but if “the abscess was not ripe, bring it out with heat.”

“If a man, his skull contains some fluid, with your thumb press several times at the place where the fluid is found. If the swelling gives way [under your finger], and [pus] is squeezed out of the skull, you shall incise, scrape the bone and [remove] its fluid…if [instead] when you press [the diseased part], the swelling does not give way [under the finger], you will make all around his head an application of hot stones [“a fire of stones”].”

It is obvious that the Asu recognized the beneficial effect of heat in accelerating the formation of an abscess. Majno placed everything into the context with regards to the development of abscesses and the action of heat: “The process (abscess formation), empirically referred to as maturation, is not an old wives’ tale but a fairly precise biological fact. It is the last stage in a sequence of events whereby a focus of infection is first surrounded by white blood cells (pus), then

walled off, cut off, and finally digested by the enzymes contained in the pus; at this stage it is 'ripe' and ready to be let out. Heat tends to speed up this process by increasing the flow of blood, hence the supply of white blood cells (Majno)." Within the magico-religious frame of Mesopotamian medicine, it is understandable that inflammation was blamed on their gods.

> *"If there is a red swelling on the man's body…it is the Hand of Sin [the Moon god]…if there is a white swelling on the man's body, it is the Hand of Shamash…if a sick man, his face, his guts, his hands, his feet are inflamed…hand of Shamash. If his guts are severely inflamed: Hand of Kubû [a demon arising from the stillborn fetus, which could turn into a wicked ghost, like the dead left without burial]."*

It is revealing to encounter no evidence of trephination or circumcision in Mesopotamian writings of the time. Excision of teeth was also not performed by Mesopotamians. The suggested eye operation for cataract removal mentioned the Code of Hammurabi, according to Oppenheim, did not represent what was implied in the code. In reality, it referred to scarification around the eye to relieve certain diseases of the eye, and not the operation for cataract we know today. The Cesarean section alluded to in a legal text of the Old Babylonian period was performed after the death of the patient. Also, the Mesopotamian surgeon did not use cautery or ligatures for bleeding vessels.

Table 3.3. Contributions of Mesopotamian surgeons[1-15]

Type of Alleged Performed Procedure	Written Confirmation
Wound Care	Yes
Abscess drainage	Yes
• Subcostal (liver or pleural)	Yes
• Scalp	Yes
Scarification around the eye	Yes
Bonesetting	Yes
Ligature of blood vessels	No
Cataract removal	No
Bleeding control—cauterization	No
Caesarean section	No

Matthew Anderson's experience illustrates the progress made since Mesopotamian times. Young Matthew progressed rather well following his miraculous brain operation. His brain scans never looked so good, according to Dr. Carson. Seven months later in March, 1994, his grandmother noticed his right eye again was not moving normally. A new brain scan demonstrated the tumor had increased in size, and again surgery was required. Ben Carson and his team at Johns Hopkins were ready!

On Monday, July 3, Matthew entered the operating room for the second time. Carson had since acquired a new tool that would allow him to be even gentler with the sensitive brain tissue. Six hours later, the meticulous surgery was finished. The surgeon had removed most of the tumor while protecting the normal tissue. At 3:55 p.m. Carson left the operating room. "The next dramatic point will be whether he wakes up O.K.," he said. Matthew hung in there strong and resourceful. CAT scan and MRI showed no tumor or worrisome fluid collection. The patient continued his speedy recovery, and by week's end, the Andersons began their return home.

It had been an incredible ordeal, but one that would not have ended in success without technology and medicine's current level of sophistication. Surgeons like Ben Carson, hospitals like Johns Hopkins, and patients like Matthew could only have succeeded in this century of such triumph and accomplishments. It is not difficult to believe that our early Mesopotamian surgical ancestors were far away from even imagining the enormous mountains of hope and success that humans were to climb in the centuries to come. King Hammurabi would indeed have been very satisfied with surgery as it is practiced today.

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CHAPTER 4

Egypt of the Pharaohs

Writings on the First Surgical Cases: The Recognition of the Knife

> *"The Edwin Smith Papyrus has revealed to us an ancient Egyptian surgeon in contrast with the physician, as a man with the ability to observe, to draw conclusions from his observations, and thus, within the limitations of his age, to maintain a scientific attitude of mind. The author of our treatise…likewise the children of their time…ever ceased to believe in the power of magic, but they had learned…to confront a great body of observable phenomena, which they systematically and scientifically collected."*
>
> —James H. Breasted
> *University of Chicago Press*, 1930

Pyramids, sphinx, mummies, Ramses II, and Tutankhamen represent the pride and heritage of Egypt's history. Mummies have greatly fascinated people the world over. Scientists, novelists, cinematographers, and academicians have participated in and closely followed these exciting developments. Many scientists have dedicated themselves to reconstructing the earliest findings of Egyptian culture and tradition, including: Jean-Claude Goyon, historian; Marie Shoefer, textile restorer; Robert Vergenioux, anthropologist; Michel Girard, pollenologist; Roland Mourer, museum curator; Pierre Cadi, urologist; and Guillaume Hertzberg, orthopedic surgeon. These scientists, among others, represent only an example of what is required to obtain answers to complex archeological issues.

Ancient Egyptians believed in embalming the bodies of their dead to preserve them forever since "they had to pass into the next world." Egyptians developed sophisticated methods of body preservation which were demonstrated in the mummies found by archeologists in

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tombs a thousand years later. The most renowned mummies are those belonging to the pharaohs, Tutankhamen and Ramses II.

The process of mummifying was a complicated one, combining science with dexterity, understanding with belief, magic with reality. Incredibly, it required more than two months to complete the entire process. In essence, the brain was removed through the nose, the internal organs except heart and lungs were taken out through regular surgical incisions, and the abdomen was filled with linen pads. The body was then placed in sodium bicarbonate for the purpose of drying the tissues. Once this occurred, the body was wrapped with many layers of linen bandages, laid in a coffin, and placed in a tomb. The size and opulence of the tombs were directly related to the social importance of the buried body. Pharaohs had the largest and most grandiose monuments.

The Great Sphinx at Giza, near the Great Pyramid, represents Egypt at its best. Simply put, the Great Sphinx cannot exist without Egypt, and likewise Egypt cannot exist without the Great Sphinx. Standing close to it, you can feel its grandiosity at seventy-three meters long, twenty meters high, with a face four meters wide. The Avenue of the Sphinxes, near Luxor, in its splendor reflects the vision and artistic expression of the Egyptian kings.

Egyptologists for years have been puzzled by countless questions about their inscrutable land. Recently, in the Giza plateau across from Cairo and the Nile in Egypt, workers, repairing the aged Sphinx, discovered an unknown entrance to an ancient passageway. The entrance was hidden behind a one-foot thick wall leading into the body of the mysterious monument. What does this mean? Where does the passage lead? Who built it, and what mysterious rites may have been performed there? We may never know the answers, but what is certain is that this culture formed the basis of its medical practice with mystical incantations and supernatural cures. The healer appeared to be more a religious man than a physician, and medicine frequently followed practices not established through a rational approach.

With more fiction than reality, a modern Finnish writer transported us to unknown literary frontiers of Egyptian surgery. In reading the extraordinary historical novel *The Egyptian* by Mika Waltari, you cannot readily recognize the real life of a surgeon in Egypt during the 1400s B.C. The main character in this novel, Sinuhe, is a doctor who historically existed during this period of time. In this fictional account, Sinuhe knew how to perform surgery, including cranial trephination, which is surprising since there is no direct or

Figure 4.1. A relief from the Sixth Dynasty from Saqqara in Ancient Egypt (circa 220 B.C.E.) demonstrating circumcision operations (Wellcome Institute Library, London) (reproduced from Lyons AS, Petrucelli II RJ. Medicine: An Illustrated History. New York: Harry N. Abrams Inc., 1978).

indirect evidence that Egyptians ever practiced this kind of surgery. Sinuhe appeared to be well-informed, and with high principles in regards to life and medical practice, he was clearly accepted by royal Egyptian society. While enjoying this work, one must maintain historical perspective and attempt to use Waltari's fiction to gain insight into reality and to transform his narrative into more credible stories (Fig. 4.1).

For us in the twentieth century to understand what happened more than 3000 years ago is no simple task. One thing that is clear is the manner in which the Egyptians handled medicine, and the paramount importance of their gods in both society and medicine. For example, the god of Egyptian medicine, Imhotep, was Asclepias for the Greeks. Imhotep was a major deity who ruled over health and disease. But before becoming a god, Imhotep was a man, a physician serving in the court of Zoser (2980-2900 B.C.) Imhotep covered all aspects of Egyptian medicine and participated in the treatment of all diseases.

The Great Pyramid built 4500 years ago by Imhotep—physician, architect, statesman—(during the reign of Cheops 2590-2568 B.C.) is one of man's greatest achievements. Its base is huge with blocks of limestone, weighing several tons each, extending the length of 10 football fields. All this construction was completed without the assistance of the wheel which had not yet been discovered. The Great Pyramid was actually considered by Herodotus—father of history—to be one of the Seven Wonders of the Ancient World. In fact, the ruins of more than 70 pyramids can be found close to the Nile River. The Egyptians used them to bury the mummified bodies of their dead, particularly those of the pharaohs and members of the court. Scholars have felt that the pyramids' shape had significant religious meaning. In this regard, there are extraordinary mysteries which remain unsolved about the pyramids as well as other ancient developments of Egyptian culture.

While Egypt also had a significant spiritual side to its medical and surgical fields, its laws did not severely limit the surgeon's expression as Hammurabi's Code had in Babylonia. In the early years of the Egyptian civilization, medicine prospered. Good diagnoses and descriptions of disease were made by Egyptian doctors, and effective treatments were concocted from herbs and alcohol. The Egyptian emphasis on cleanliness and personal hygiene also helped limit infectious diseases. With his contributions to medicine and his successful treatments, Imhotep was transformed from a mortal physician to a medical god. After his death, many temples of worship were constructed in his honor throughout Egypt.

In their legendary papyri, Egyptian doctors described with exceptional clarity the characteristics of their medical practice. They clearly outlined many of their remedies, herbal medicines, different concoctions, and multiple treatments of ways to treat disease through surgery. No other civilization before them defined so well the details of so many diseases, treatments, and surgical matters. Nine Egyptian

medical papyri, each originating before the second millennium before Christ, have been discovered. One such papyrus, the Ebers, deals mainly with diagnosis and prescription, while another, the Kahun, is oriented towards the use of concoctions for various illnesses as well as the management of gynecological problems. However, of these papyri, our major interest resides in the Edwin Smith Papyrus, which is exclusively dedicated to surgery.

The Edwin Smith Papyrus represents a unique work of Egyptian surgical literature, one that is considered to be the closest to modern scientific medicine. It is not known who was the author or authors of this magnificent book of surgical events, but it appears to have originated in the times of the Old Kingdom, approximately 3000-2500 B.C. This manuscript was copied several times by various surgeons or scribes until its initial discovery in Thebes, in 1862, by a young American Egyptologist, Edwin Smith. Smith did not publish his findings, but instead asked James Henry Breasted, of the Oriental Institute of the University of Chicago to translate the papyrus. It took several years, but in 1930, the entire manuscript came out in book form.

The Smith Papyrus contains twenty-one and a half columns of writing, 17 of which (377 lines) are on the front (recto), with the remaining four and a half columns (92 lines) on the back (verso). The material on the verso consists of recipes and incantations. The document on the recto, which is about six-sevenths of the entire manuscript, contains exclusively surgical cases, not recipes. It is organized systematically, beginning with injuries of the head and progressing down to the other portions of the body. The treatment is rational and surgical except in two cases. Forty-eight cases are described, of which the great majority are injuries or conditions induced by injuries.

The book abruptly stops at this point, and it is possible that it would have continued to the lower parts of the body until the feet, had it been finished (Table 4.1).

The ancient Egyptian surgeon discussed his cases in a well defined pattern, with the inclusion of the following elements: (1) Title, (2) Examination, (3) Diagnosis, (4) Treatment (unless the case was untreatable), and (5) Glossaries, which are explanations of unknown terms. The surgeon also gave a prognosis based on the characteristics of the injury. In this way, his verdict was: (a) an ailment which I will treat, (b) an ailment with which I will contend, and (c) an ailment not to be treated. The surgeon was then able to render a good, bad, or questionable prognosis and therefore recommend his treatment.

Table 4.1. Cases contained in the Smith Papyrus[1]

A. Head

Case 1 A wound in the head, penetrating to the bone (incomplete)
Case 2 A gaping wound in the head, penetrating to the bone
Case 3 A gaping wound in the head, penetrating to the bone and perforating the skull
Case 4 A gaping wound in the head, penetrating to the bone and splitting the skull
Case 5 A gaping wound in the head with compound comminuted fracture of the skull
Case 6 A gaping wound in the head with compound comminuted fracture of the skull and rupture of the meningeal membranes
Case 7 A gaping wound in the head, penetrating to the bone and perforating the sutures
Case 8 Compound comminuted fracture of the skull displaying no visible external injury
Case 9 Wound in the forehead producing compound comminuted fracture of the skull
Case 10 Gaping wound at the top of the eyebrow, penetrating to the bone
Case 11 A broken nose
Case 12 A break in the nasal bone
Case 13 Compound comminuted fracture in the side of the nose
Case 14 Flesh wound in one side of the nose, penetrating to the nostril
Case 15 Perforation of the bone in the region of the maxilla and zygoma
Case 16 Split of the bone in the region of the maxilla and zygoma
Case 17 Compound comminuted fracture of the bone in the region of the maxilla and zygoma
Case 18 Wound in the soft tissue of the temple, the bone being uninjured
Case 19 Perforation in the temple
Case 20 Wound in the temple, perforating the bone
Case 21 A split in the temporal bone
Case 22 Compound comminuted fracture of the temporal bone
Case 23 Slit in the outer ear
Case 24 Fracture of the mandible
Case 25 Dislocation of the mandible
Case 26 Wound in the upper lip
Case 27 Gaping wound in the chin

B. Throat and Neck

Case 28 Gaping wound in the throat, penetrating to the gullet
Case 29 Gaping wound in a cervical vertebra
Case 30 Sprain in cervical vertebra
Case 31 Dislocation of a cervical vertebra
Case 32 Displacement of a cervical vertebra
Case 33 Crushed cervical vertebra

continued on next page

Table 4.1. Continued

C. Clavicle
Case 34 Dislocation of the two clavicles
Case 35 Fracture of the two clavicles

D. Humerus
Case 36 Fracture of the humerus
Case 37 Fracture of the humerus with rupture of overlying soft tissue
Case 38 Split in the humerus

E. Sternum, Overlying Soft Tissue and True Ribs
Case 39 Tumors or ulcers in the breast, perhaps resulting from injury
Case 40 Wounds in the breast
Case 41 Infected or possibly necrotic wound in the breast
Case 42 Sprain of the sterno-costal articulations
Case 43 Dislocation of the sterno-costal articulations
Case 44 Fractured ribs
Case 45 Bulging tumors in the breast
Case 46 Abscess with prominent head on the breast

F. Shoulder
Case 47 Gaping wound in the shoulder

G. Spinal column
Case 48 Sprain in a spinal vertebra (incomplete)

A review of some of the actual reported cases exemplifies the depth and knowledge of the Egyptian surgeon.

Case 6

Title	Instructions concerning a gaping wound in his head, penetrating to the bone, smashing his skull, and rending open the brain of his skull
Examination	If thou examinest a man having a gaping wound in his head, penetrating to the bone, smashing his skull, and rending open the brain of his skull, thou shouldst palpate his wound. Shouldst thou find that smash which is in his skull like those corrugations which form in molten copper, and something therein throbbing and fluttering under the fingers, like the weak place of an infant's crown before it becomes whole—when it has happened there is no throbbing and fluttering under thy fingers until the brain of his (the patient's) skull is rent open—and he discharges blood from both his nostrils, and he suffers with stiffness in his neck,
Diagnosis	Thou shouldst say: "An ailment not to be treated."

Treatment Thou shouldst anoint that wound with grease. Thou shall not bind it; thou shalt not apply two strips upon it: until thou knowest that he has reached a decisive point.

Gloss A As for: "Smashing his skull, and rending open the brain of his skull," (it means) the smash is large, opening to the interior of his skull, to the membranes enveloping his brain, so that it breaks open his fluid in the interior of his head.

Gloss B As for: "Those corrugations which form on molten copper": It means copper which the coppersmith pours off (rejects) before it is forced into the mould, because of something foreign upon it like wrinkles. It is said: "It is like ripples of pus."

Case 10

Title Instructions concerning a wound in the top of a man's eyebrow.

Examination If you examine a man having a wound in the top of his eyebrow, penetrating to the bone, you should palpate his wound, and draw together his gash for him with stitching.

Diagnosis You shall say concerning him: "A man having a wound in his eyebrow. An ailment which I will treat."

Treatment After you have stitched it, you should bind fresh meat upon it the first day. If you find that the stitching of the wound has come loose, you should draw it together for him with two strips of plaster, and you should treat it with grease and honey every day until he recovers.

Gloss '*Two strips*'—this means two bands of linen, which one applies to the two lips of a gaping wound, in order to make one lip join the other.

Case 31

Title Instruction concerning a dislocation in a vertebra of man's neck.

Examination If you examine a man having a dislocation in a vertebra of his neck, if you find him paralyzed in both arms and both legs because of it, with his phallus erect because of it, and urine drips from his penis without his knowing it;….and his eyes are bloodshot, it is a dislocation of a vertebra of his neck extending to his spine which is making him paralyzed in both arms and legs. If the middle vertebra of his neck is dislocated, this is the cause of seminal emission which happens to his phallus.

Diagnosis You shall say concerning him: "He is a man having a dislocation in a vertebra of his neck, whilst he is paralyzed in his two legs and two arms, and his urine dribbles. An ailment which I will not treat."

Gloss '*A dislocation (wnh) in a vertebra of his neck*'—he is speaking of a separation of one cervical vertebra from another, the overlying flesh being uninjured; as it is said of things which had been joined together, when one has become separated from the other, it is '*wnh*'. '*a seminal emission which happens to his phallus*'—it means that his phallus is erect and has a discharge… '*his urine dribbles*'—it means that urine drips from his phallus without his control (literally 'and he cannot restrain').

It is evident then, that Egyptian surgeons were far ahead of their time in the theory and practice of surgery. They knew how to assess the severity of an injury, how to take care of traumatic or surgical wounds, and how to suture them appropriately. It is recorded that they would "stitch up wounds with sutures or close them with linen-based adhesive plaster." Additionally, "wounds were treated by the modern method of bringing the raw edges together, but were kept in place by means of bandages obtained from embalmers." These treatments remained prominent in their practice as they have in the practice of our surgical contemporaries (Table 4.2).

Egyptians also made important developments in the field of surgical instruments. Thanks largely to their background in mummification, they invented better instruments for incision and extraction, probably allowing careful removal of organs during mummification without disfiguring the corpse. Several excavations from tombs yielded multiple kinds of surgical blades (made of bronze, stone, metal and

Table 4-2. Contributions of Egyptian surgeons[1,4,5,9,10]

Type of Alleged Performed Procedure	Written Confirmation
Wound care	Yes
Management of compound fractures	Yes
Management of spinal injuries	Yes
Circumcision	Yes
Removal of urinary bladder stones	No
Male castrations	No
Bleeding control—cauterization	No

Figure 4.2. Egyptian surgical instruments visualized in the middle of the wall of the Twin Temple of Kom Ombro on the Nile. (Reproduced from Lyons AS, Petrucelli II RJ. *Medicine: An Illustrated History*. New York: Harry N. Abrams Inc., 1978.)

papyrus reed), forceps, hooks, needles, and other materials. With the lack of precise surgical records, it is impossible to know exactly how the Egyptians used their instruments, or the full extent of their surgical knowledge. Fortunately, the Egyptians had a strong cultural exchange with the Greeks before the Egyptian decline, and many Egyptian surgical secrets undoubtedly lived on through Greek civilization (Fig. 4.2).

For all of us, the Egypt of today is different from the Egypt of yesterday. At present, we can only remember the Egypt of Anwar el-Sadat, and the signing of the peace treaty with Israel's Menachim Begin with Jimmy Carter as a witness. We also remember the assassination of Sadat in 1981, as well as the assumption of power of Hosni Mubarak. Poverty, illiteracy, and population explosion are frequently brought to our attention by international news, reminding us of the unfortunate condition of the country. Egypt is recognized today for all these various aspects, and we no longer think of it as an eminent center of medicine. But at one time the contributions made by Egyptians were the most significant in the world.

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CHAPTER 5

Hindu Tradition

The World of Sushrupta Samhita: Another View of the Knife

> *"The great flowering of surgery in early Indian medical history is particularly significant in view of the obstacles that stood in the way of the study of anatomy. According to the Hindu tenets the human body is sacred in death. It may not be violated by dissection…the corpses of all persons more than two years old must be cremated in their original condition…anatomical knowledge was pursued secretly and only in cases where unclaimed bodies were found."*
>
> —L.M. Zimmerman and I. Veith
> *Great Ideas in the History of Surgery*, 1961

The mature, Oxford-educated Indian surgeon, a colleague and friend, reminisced about his early medical, school years in Chandigahr. He had pondered many times why the India of his dreams had remained so far behind the world's leading medical powers. How could the accomplishments of yesterday not be seen in India's medical sciences of today? Why did this aspiring surgeon have to go west to acquire the surgical knowledge that had escaped contemporary India? With more questions than answers, he returned to his native land to instill new principles and ideas in the practice of surgery. He brought to India the expertise of transplantation surgery and its related fields. He undertook the monumental task of applying his recently acquired knowledge and techniques to the retrograde methods still utilized in India. An introduction to India's surgical mentors underscores the wonders achieved by their ancient surgery.

Not easily understood are the complexities and intricacies of this mysterious country. India is a land of multiple races, cultures, and religions; a land of over-population, poverty, and tradition; a land of tolerant people, natural resources, and uncountable possibilities.

Origins of the Knife: Early Encounters with the History of Surgery,
edited by Luis Horacio Toledo-Pereyra. ©2006 Landes Bioscience.

From the Aryans (c. 1500 B.C.)—early fair-skinned immigrants from central Asia who perfected the Sanskrit language—to Alexander the Great (326 B.C.), to the British invasion (1757), Indians have shown an incredible resilience to intruders and epidemics alike. They fought disease and amalgamated with foreigners in their own land. To enter India's tradition is to revive 4500 years of invasion and tolerance, it is to remind us of thousands of years of mystery and excitement, it is to recognize the early advances of their medical practices.

Recent discoveries of the ruins of Harappa and Moen-jo-daro in northwest India demonstrated progressive systems of counting, measuring, weighing, and writing. These ancient people of the "Indus Valley Civilization" were advanced in their practice of medicine as well. They believed in hygiene and preventive medicine as a means to prolonged life. India's earliest medical writings, the *Ayurveda*, represented the science of life, the science of longevity. The *Ayurveda* contained eight branches of medicine: internal medicine, surgery, diseases of the head, pediatrics, toxicology, demonic diseases, rejuvenation, and aphrodisiacs. The original writings which occurred possibly centuries before the Christian era, did not include surgical matters. It was because the great majority of the physicians belonged to the Brahmin caste and any treatment of wounds or injuries was considered inferior. Surgeons were part of a lower, illiterate caste passing on their knowledge only by oral tradition.

Siddharta Gautama (583-483 B.C.), later known as Buddha (Enlightened One), was born at the foothills of the Himalayas in present-day Nepal. At age 29 Gautama became a wandering monk pursuing enlightenment and religious contemplation. Buddha preached that people entrenched in the suffering of life could find release in Nirvana, a state of happiness and peace. Dharma was his message of an existence that cycled through in death and rebirth. Buddha recommended the Noble Eightfold Path of truth, respect, freedom, control, morality, and concentration, among others. Thus, Buddhism remained as the main religion of India's ancient times.

Hundreds of years later, Hinduism replaced Buddhism throughout India. Hindus progressively incorporated many beliefs, cultures, and religions integrating them into their own religion. Hinduism embraced many gods and sacred writings, such as the *Vedas*, the *Bhagavadgita*, the *Manu Smriti*, and others. A system of castes and reincarnation of the soul, known as Karma, represented an important tenet of Hindu beliefs. Religion was a fundamental component

of medical practice and was intimately associated with their therapeutic approach.

Alya, the term for arrow which also referred to surgery, did not become accepted in the traditional system of the medicine of India (*Ayurveda*) until the first century A.D., even though it had existed for centuries. As in many other cultures (i.e., Greek, Roman, etc.), surgery grew from the care of battle wounds. The question of who was going to close the enormous gap existing between the Brahmin physician and the war surgeon was still unanswered until the appearance of the extraordinary works of Sushrupta, the *Sushrupta Samhita* which became the classic surgical text of India.

When the *Sushrupta Samhita*, the encyclopedic surgical book, was written is not certain. Whether Sushrupta was a historical figure or a mythical personage is also unknown. Indian tradition calls for acceptance of this work regardless of the time of writing or the veracity of the author. Some scholars place Sushrupta as a contemporary of Buddha (500 B.C.), since Sushrupta was a disciple of the holy Dhamvantari. The writings appear to be of those times. Others locate Sushrupta after Christianity began. For the purpose of historical continuity, this chapter is presented before the Greeks and the Chinese and Romans. In any event, the importance of Sushrupta's work extends through generations to our times.

Sushrupta divided surgery into eight procedures: incision, excision, scarification, aspiration, extraction, evacuation, probing, and suturing. The text described 121 sharp and blunt instruments the majority of which were sharp, such as knives, lancets, scissors, trocars and saws (Fig. 5.1). Other instruments included forceps, tubes, catheters, sounds, hooks, etc. The disciples of Sushrupta developed 14 different types of dressings made from various materials, such as silk, linen, cotton, and wool. Multiple splints were introduced, fashioned from the typical forest trees growing in the area; bamboo, bark, etc. Anesthesia included the use of alcoholic compounds that produced various degrees of intoxication. Bleeding was controlled through several means, including compression, hot oil, and herbs.

Ancient Indian surgeons reached high levels of clinical surgical practice. Their mastery of skills, use of instruments, and consummation of the surgical act were unmatched among surgeons of the times. Even though their knowledge of anatomy and physiology did not reach the heights of Greek medicine and surgery, their surgical diagnosis and treatment equaled that of the Hellenic surgeons and grew beyond that of the Egyptians

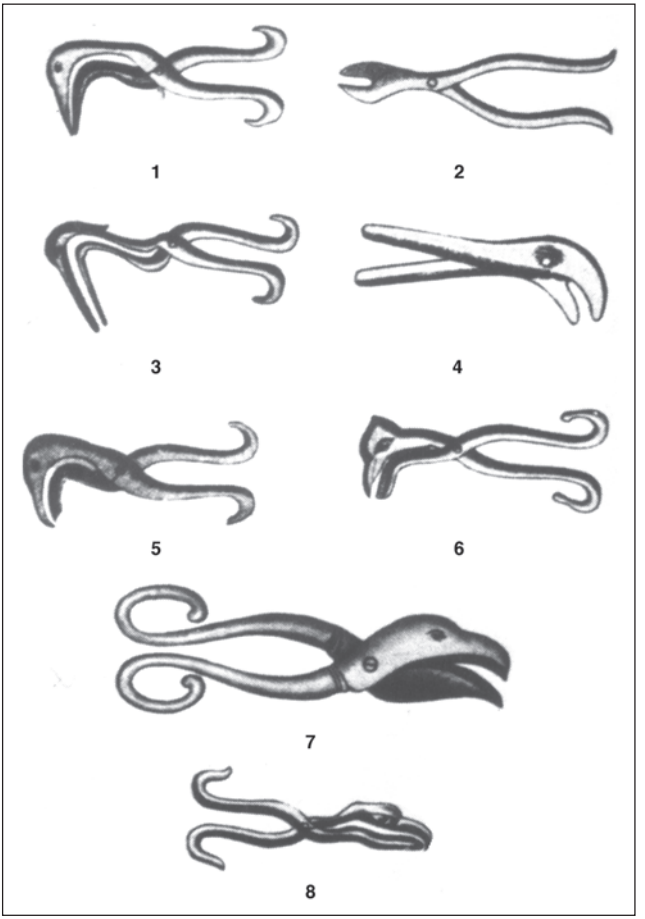

Figure 5.1. Ancient Indian surgical instruments demonstrating similarity to animal heads (Pandit Sharma, Bombay) (reproduced from Lyons AS, Petrucelli II RJ. *Medicine: An Illustrated History*. New York: Harry N. Abrams Inc., 1978).

Sushrupta and two other physicians, Charaka and Vagbhata, were the legendary founders of the classic surgical and medical Indian texts "that illuminate the eight branches of Ayurvedic medicine". They were honored as the "Triad of Ancients". Charaka lived—according to some historians—around 800 B.C. and participated in the writing of the *Charaka Samhita*. This great medical textbook described hundreds of drugs, analyzing them in regards to the diseases for which

they were effective. Vagabhata was the youngest of all ancient Indian physician authors, and, like the other two, his biography was not adequately preserved for future generations to study. However, one thing is known, Vagabhata recognized in his textbook the works of Charaka and Sushrupta. Specific dates are not known, but this ancient master most likely practiced several hundred years after the writings of the other members of the Triad were published.

The *Sushrupta Samhita* represents "the beginning and the end, the peak and the valley," the only real work of Indian medicine dealing with surgery. Of all branches of the *Ayurveda*, surgery is the highest in value, and according to Sushrupta:

> *"It is eternal and a source of infinite piety, imparts fame and opens the gates of Heaven to its votaries, prolongs the duration of human existence on earth, and helps men in successfully fulfilling their missions and earning a decent competence in life."*

Sushrupta was well informed of other branches of medicine including hygiene, general diseases, diet, exercise, and healing plants, of which he listed 760. Sushrupta was a surgeon, a fact categorically emphasized in his book. He understood the scope of surgery and its function in dominating disease. He believed in harmony and imbalance, which represented health and disease. He recognized the importance of accurate diagnosis in rendering a fair prognosis. He defined the characteristics and solemn principles of the physician-surgeon that he should follow in the practice of his profession. This teaching was very much in agreement with the Hippocratic oath, causing scholars to wonder whether Sushrupta knew some of the concepts developed from previous Greek influences, or whether he antedated Hippocrates by a century or two. Unfortunately, as previously stated, the precise timing of Sushrupta writings is unknown.

The *Sushrupta Samhita* described many operations performed by the Indian surgeon of the day. Techniques dealing with pain and infection were incorporated in their armamentarium. We alluded to the use of alcohol, such as wine, "to prevent fainting and to deaden pain. The fumes of burning Indian hemp had a narcotic effect and were frequently utilized by practicing surgeons. Bleeding was controlled through cauterization. Sushrupta discovered red-hot irons to be superior to the chemically induced cautery burn.

The Indian surgeon of Sushrupta's times utilized a great number of surgical procedures. Some of them were operations for cataracts

(couching), removal of bladder stones (lithotomy), repair of injured bowels (through laparotomy), drainage of pus from the chest cavity, reconstruction of noses, lips, and ears, and the use of large black ants as wound clips for closure. The Indian surgeon was imaginative, courageous, and meticulous in the development of his art.

5

One important aspect of surgical treatment in ancient India was plastic surgery, an area where great contributions were made. The Indian surgeon developed the skin-flap technique, which consisted of creating a portion of skin from nearby tissue to substitute for the damaged region on the face. Lois Magner, a noted historian, clearly described this technique:

> *"Repairs of noses, lips and ears were made with the "sensible skin-flap" technique. For example, using a leaf as his template, the surgeon would slice a patch of "living flesh" (now called the pedicle flap) from the cheek or forehead in order to create a new nose. After scarifying the patch, the physician quickly attached it to the site of the severed nose and covered the wound with an aesthetically pleasing bandage. Because a pedicle flap used as a graft must remain attached to its original site, the free end can only be sewn to an area within easy reach. After the graft had grown attached to the new site, the base of the flap was cut free. If the surgeon had superb skill, steady hands and sharp razors, the operation could be completed in less than two hours."*

Other surgeries performed by ancient Indian surgeons included amputations and tonsillectomies. Cesarean section was practiced, but only after death of the mother or fetus, as in the case of embryotomy following fetal demise. "Fractures, dislocations, the extirpation of tumors, the cauterization of fistulae, the removal of foreign bodies and the performance of paracentesis were rationally and intelligently described", according to Zimmerman and Veith. Wounds were managed by the best techniques, utilizing cleansing "both of its inside and exterior" and closure by suture or large black ants, as described before.

We have considered the surgical developments of early Indian surgeons, and we have presented details of their sophisticated techniques, but we have not yet entered the realm of selection, training, and aptitudes of the ancient surgeon. The *Sushrupta Samhita* explicitly describes the characteristics sought in the training and selection of the ancient Indian surgeon:

"…The formal initiation of a pupil into the science of medicine…should be imparted to a student, belonging to one of the three twice-born castes such as, the Brahmana, the Kshatriya, and the Vaishya, and who should be of tender years, born of a good family, possessed of a desire to learn, strength, energy of action, contentment, character, self-control, a good retentive memory, intellect, courage, purity of mind and body, and a simple and clear comprehension, command a clear insight into the things studied. . . .a man possessed of contrary attributes should not be admitted into (the sacred precincts of) medicine.

Next, the *Sushrupta Samhita* relates the principles and ideals of the pioneer surgeon of the past. It is as if the Indian surgeon is being asked to take an oath that could be called Sushtupta's Oath, similar to the one named after Hippocrates, a contemporary.

…the preceptor should address the initiated disciple as follows:–Thou shalt renounce lust, anger, greed, ignorance, vanity, egotistic feelings, envy, harshness, niggardliness, falsehood, idleness, nay all acts that soil the good name of a man. In proper season thou shalt pare thy nails and clip thy hair and put on the sacred cloth, dyed brownish yellow, live the life of a truthful, self-controlled anchorite and be obedient moving about–while at meals or in study, and in all acts thou shalt be guided by my directions. Thou shalt do what is pleasant and beneficial to me, otherwise thou shalt incur sin and all thy study and knowledge shall fail to bear their wished for duties, and thou shalt gain no fame. If I, on the other hand, treat thee unjustly even with thy perfect obedience and in full conformity of the terms agreed upon, may I incur equal sin with thee, and may all my knowledge prove futile, and never have any scope of work or display. Thou shalt help with thy professional skill and knowledge, the Brahmanas, the elders, preceptors and friends, the indigent, the honest, the anchorites, the helpless and those who shall come to thee (from a distance), or those who shall live close by, as well as thy relations and kinsmen [to the best of thy knowledge and ability], and thou shalt give them medicine [without charging for it any remuneration whatever], and God will bless thee for that.

Thou shalt not treat medicinally a professional hunter, a fowler, a habitual sinner, or him who has been degraded in life; and even by so doing thou shalt acquire friends, fame, piety, wealth and all wished for objects in life and thy knowledge shall gain publicity."

5 A more detailed explanation is given to us by Sushrupta's writings in regards to the training of the ancient Indian surgeon:

"The preceptor should see that his disciple attends the practice of surgery even if he has already thoroughly mastered the several branches of the science of Medicine, or has perused it in its entirety. In all acts connected with surgical operations of incision, etc., and the injection of oil, etc., the pupil should be fully instructed in regards to the channels along or into which the operations or applications are to be made (Karma-patha). A pupil, otherwise well-read, but uninitiated into the practice (of medicine or surgery) is not competent (to take in hand the medical or surgical treatment of a disease). The art of making specific forms of incision should be taught by making cuts in the body of a Pushpaphalá (a kind of gourd), Alávu, watermelon, cucumber, or Erváruka. The art of making cuts either in the upward or downward direction should be similarly taught. The art of making excisions should be practically demonstrated by making openings in the body of a full waterbag, or in the badder of a dead animal, or in the side of a leather pouch full of slime or water. The art of scraping should be instructed on a piece of skin on which the hair has been allowed to remain. The art of venesection (Vedhya) should be taught on the vein of a dead animal, or with the help of a lotus stem. The art of probing and studding should be taught on worm-eaten wood, or on the reed of a bamboo, or on the mouth of a dried Alávu (gourd). The art of extracting should be taught by withdrawing seeds from the kernel of a Vimbi, Vilva or Jack-fruit, as well as by extracting teeth from the jaws of a dead animal. The act of secreting or evacuating should be taught on the surface of a Shálmali plank covered over with a coat of bee's wax, and suturing on pieces of cloth, skin or hide. Similarly the art of bandaging or ligaturing should be practically learned by tying bandages round the specific limbs

and members of a full-sized doll made of stuffed linen. The art of tying up a Karna-sandhi (severed ear-lobe) should be practically demonstrated on a soft severed muscle or on flesh, or with the stem of a lotus lily. The art of cauterization, or applying alkaline preparations (caustics) should be demonstrated on a piece of soft flesh; and lastly the art of inserting syringes and injecting enemas into the region of the bladder or into an ulcerated channel, should be taught (by asking the pupil) to insert a tube into a lateral fissure of a pitcher full of water, or into the mouth of a gourd (Alávu)."

After having described all the significant accomplishments of India's surgery, it is hard to believe that our contemporary society does not recall all these great contributions.[1-11] With more than 15 percent of the world population, India has everything—desert, mountains, and rain forest. The tallest mountain range, the Himalaya, is shared with China. One of the modern world's seven wonders, the Taj Mahal in Agra, Northern India, was built from 1632 to 1653 by 20,000 workers to host the white marble shrine of Shah Jahan and his wife.

India has been plagued with political turmoil, particularly during the last few decades. Mohandas Gandhi remains as the greatest contemporary leader of the independence movement. Due to his visionary and courageous attitude and following his non-violent disobedience credo, on August 15, 1947, India gained its independence from England. Yet, this historical change did not bring an improved medical system. Medicine as a whole, and surgery as one of its branches lagged far behind the development of similar disciplines in other countries. India did not maintain the pace of progress attained by other nations. Even today, India's medicine has not reached the degree of sophistication seen in the developed nations. One could say that the science and art of Sushrupta, which acquired the highest levels of knowledge and practice, slowed and stagnated.

As my friend the Indian transplant surgeon dozed back from his dreams and unwanted realities, it was important for him to recognize that the India of today did not reflect the glory of the "Ancient Masters," that the India of today did not recall their ancestor's knowledge of surgery and medicine, and that the India of today did not demonstrate the accomplishments of ancient India.

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CHAPTER 6

Ancient China
A Land of Unrealized Expectations

> *"While modern Western medicine employs technology as a weapon of war against the forces of nature involved in human disease, with the body as a battlefield, Chinese medicine tries to harness, harmonize, and deflect malevolent energies to rebalance and retune the whole human system… And some modern Western therapies such as surgery, radiation, chemotherapy, and chemical drugs, are highly intrusive and sometimes toxic to the human system."*
>
> —D. Reid
> *Traditional Chinese Medicine* 1996; 5-6

China is a legendary nation of proud heritage and exuberant traditions, of cherished dreams and unrealized expectations, and of countless stories of the past and endless possibilities for the future. China, a populous nation of one billion people, represents the world's oldest living civilization of 3500 years. Multiple dynasties, starting with Shang, Chou, Ch'in, Hank Tang, Sung, and the Mongol Empire dominated and directed China's destiny for years.

The Chinese contributed more to the development of medicine than to surgery or anatomy. Around the fourth and fifth century B.C., the creation of the *Huang Ti Nei Ching Su Wen* or *The Yellow Emperor's Classic of Internal Medicine*, reflected the serious commitment and understanding of the Chinese in the practice of medicine. The combination of Chinese medicine with Chinese religious beliefs was evident, more so when they considered medicine as part of philosophy and religion. The foundations of Chinese medicine were based upon the acceptance of the universe as a whole, the understanding of nature in the evolution of the world, and the belief in the concepts of Tao (natural philosophy of universalism), Yin and Yang (primogenital

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opposite forces from which the universe was created), and the theory of elements, which form art of all living matter.

The Yin and Yang are important concepts of the Chinese medicine as expressed in the following passages of the *Huang Ti Nei Ching Su Wen*:

6

> *"The principle of Yin and Yang is the basis of the entire universe. It is the principle of everything in creation. It brings about the transformation to parenthood; it is the root and source of life and death…*
>
> *Heaven was created by an accumulation of Yang; the Earth was created by an accumulation of Yin.*
>
> *The ways of Yin and Yang are to the left and to the right. Water and fire are the symbols of Yin and Yang. Yin and Yang are the source of power and the beginning of everything in creation.*
>
> *Yang ascends to Heaven; Yin descends to Earth. Hence the universe (Heaven and Earth) represents motion and rest, controlled by the wisdom of nature. Nature grants the power to beget and to grow, to harvest and to store, to finish and to begin anew."*

The Chinese commitment to Confucian philosophy, the respect for the human body in life and death did not permit the development of anatomical studies of surgical practice. Instead, the emphasis was placed on preventive medicine. The human body was a "flourishing, living garden", and the doctor cared for it in the best way possible. Chinese medicine attempted to restore the human body to a state of harmony and equilibrium. The orientation and direction of the human energy was of paramount importance to the Chinese doctor. His function was one of maintaining the forces of the body within balance so disease could not take root. Under these conditions, it would be impossible for a surgeon to emerge and in fact, it would take many centuries before a surgeon could be identified!

Old China did not share in the surgical accomplishments of other civilizations that flourished during the same period. While ancient India, Mesopotamia, and Egypt recognized and embraced the presence of the knife, the reaches of surgery were far less advanced for the Chinese. They concentrated on other means to attend the body, whether dead or alive. They emphasized medical principles in their practice with a strong traditional background, which included manipulative therapy and exercise.

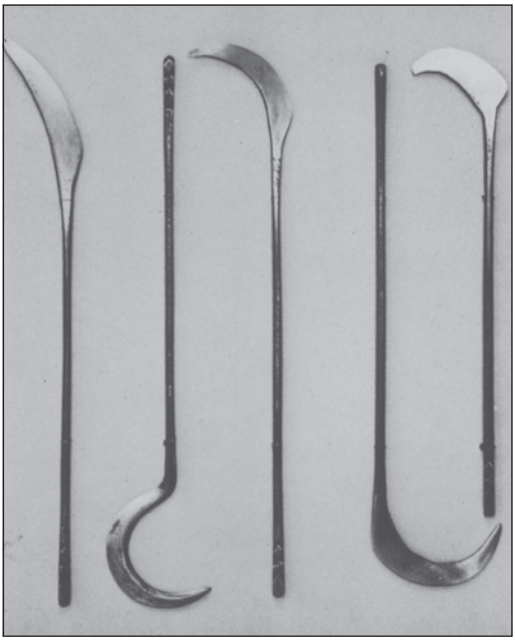

Figure 6.1. Ancient Chinese surgical knives (Wellcome Trustees, London). (Reproduced from Lyons AS, Petrucelli II RJ. *Medicine: An Illustrated History*. New York: Harry N. Abrams Inc., 1978.)

After Richard Nixon's extraordinary visit to China in 1972, the way was cleared for China to establish normal relations with the United States. Perhaps too much hope was placed in the significance of this event as to the potential role China might have played in the world. In *China Wakes: The Struggles for the Soul of a Rising Power*, Kristof and Wu Dunn captured the current status of this nation. They conveyed their views as to how the "slumbering giant was awakening socially, economically, and politically." Only the future would tell us about the reality of this untamed country, but in regards to surgical matters, there were no significant advances forthcoming. China remained attached to traditionalism and restrained itself from many new findings in the use of the knife (Fig. 6.1).

In 1974, the buried art of Ancient Xi'an was discovered. A terra-cotta army of 7,000 fully-equipped, life-size soldiers and horses is encountered in the tomb of the First Emperor, Qin Shin Huang. This monarch unified China in 221 B.C., and the sole finding of his terra-cotta army stimulated the imaginations of people around the

world. Remarkably, the creation of such magnificent art did not correspond with important advances in the medical and surgical sciences.

Even though there were no surgical texts from ancient China, swellings, ulcers, and wounds appear to have been treated with plasters, scrapings and cauterization. The Chou Dynasty (1122-249 B.C.), which lasted for almost a millennium before the advent of Christianity, was the main scenario of these minor developments. The Chinese did not fully recognize surgery and its clinical significance until Hua To came to life in the second century A.D. Even then, Chinese physicians continued to emphasize the significance of herbs, diet and nutrition, fasting, massage, breathing, and exercise as important measures in maintaining human health.

Hua To (190-265 A.D.), born in the district of Po in the province of Anhwei, was the great master of surgery in early China. He shares a place with Pien Ch'iao (second century B.C.), as the most accomplished of Chinese surgeons. Hua To's techniques were equivalent to those of other great ancient surgeons of the world. As was expected in those times, Hua To practiced both medicine and surgery simultaneously, concerning himself also with matters of diagnosis, prognosis, and conservative management. Under his surgical care, Hua To utilized principles of acupuncture (anesthesia through needles) and moxibustion (analgesia through heat from wood campfires), both of which were frequently used by Chinese practitioners of the day.

The completion of 4,000 miles of Great Wall across northern China represented the commitment and determination of this incredible Asiatic nation. Keeping in mind the extraordinary nature of this wondrous feat, it is not hard to believe that these citizens were also advanced in other sciences in addition to engineering, physics, and mathematics. The Chinese developments in medicine and surgery, however, were limited by their philosophical beliefs. Indeed, philosophy took over medicine! Way-of-living principles dominated the practice of medical care. Surgery did not have room to expand, and anatomy, and physiology were not thought about by the medical masters.

The modern China of the cultural revolution (1966-1969) broke away from previous educational systems. The China Communist Mao Zedong attacked long centuries of effort and accomplishments. Cultural and social advancement came to a standstill, as if the process of thinking had been frozen and intellectual exchange had ceased. Of course, medicine and principally surgery were part of this academic blockade, as if the surgical sciences had not been blocked already by centuries of stagnation and lack of support. Even

today, medical sciences remain relegated to distant terrain, particularly when compared with the medicine of the West.

Returning to our main protagonist, Hua To was indeed a unique surgeon in Chinese history. He discovered the use of potent anesthetic, *ma fei san* (Indian Hemp), which could be equated to opium in our time. Besides venesection and acupuncture, Hua To apparently performed a great number of operations, such as laparotomies with excision of small intestine, liver, or spleen. On the next page, we will return to review the authenticity of his surgical procedures. Hua To also was familiar with trephination, which he offered to Ts'zo Ts'ao, a king from northern China who had violent headaches. The king did not accept this procedure, but tolerated acupuncture well, thereafter giving his respect and admiration to his healer. Hua To appeared to be an able operator who could perform any surgery in his time.

As well as a skillful practitioner of acupuncture, Hua To was also an excellent anatomist and an accomplished therapeutic strategist. Huard and Wong take us to specifics of his work:

> *"When Hua To acknowledged that acupuncture had to be used he would apply it in two or three places; he carried out the same procedure in the case of moxa if it was indicated by the nature of the affection to be treated. But, if the source of the ailment was in those parts of the body where the needle, the moxa and liquid applications could have no effect, for example in the bones, the bone marrow, the stomach or the intestines, he gave a preparation of hemp (may-yo) to the patient, who after a few moments would become as insensate as if he were completely intoxicated or deprived of life. Then he would cut open, make incisions or amputate as required and remove the cause of the illness; but he would stitch together the tissues and apply liniments. After a certain number of days (at the end of the month according to the reckoning of the later Han period) the patient would be well again without having felt the slightest pain during the operation."*

Hua To used sutures, antiseptics and ointments to cure inflammations and he used *antihelminthics* for treating intestinal parasites, *Ascarides*, notably ta-suan (*Alliuim scorodoprasum L.* or tape worms) with a mixture of vinegar. In obstetrics, he diagnosed intrauterine death and utilized acupuncture before delivery. He performed castrations (known before his times) which were of particular importance since the Imperial Court needed eunuchs to care for the emperor.

Tragically, Hua To's works were destroyed, and thus, we do not have a way to report his work accurately. Consequently, the possibility does exist that Hua To's works were more of a legend than accepted historical events. Even though there appears to be no doubt that Hua To existed as a practicing physician and surgeon, the type of procedures he performed are, at this point, more speculative than factual.

6

Several other puzzling questions remain, particularly in relation to the training and development of Hua To. Did he get his formative experience from the West? Was he exposed to Greek medicine, and if so, how and when? Were eastern surgeons as advanced in their own terms as their western counterparts? Was Hua To influenced by Hindu surgeons? How was he able to part from Confucian philosophy, which was so ingrained in the Chinese way of life? Again, clear answers for these questions are not possible, since early writings of Chinese surgery were not preserved. Other sources—which at this stage are not available—might give us some insight into these issues. Only the discovery of new ancient writings could help us to decipher the real scope of Chinese surgery, which for now, we must consider to have been at an elementary level.[1-12]

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CHAPTER 7

Greek Civilization

A Rational Approach to Medicine: A Defined Role of the Knife

> *"A brief, and I believe accurate, statement of the scope of Hippocratic surgery may here be of interest. 'They reduced fractures and dislocations; they applied the apparatus necessary to retain the displaced parts; they resected the ends of projecting bones in compound fractures, they trepanned the bones of the cranium, and the ribs even, to evacuate fluids accumulated in the chest; they performed the operation for paracentesis of the chest and abdomen; they opened abscesses of the kidneys and the liver; they operated for fistulae in ano and for hemorrhoids; they cauterized the shoulder to prevent the recurrence of certain scapulo-humeral dislocations; they adjusted club feet, they sounded the bladder; they amputated the dead portion of gangrenous limbs; they rasped the bones of the cranium; they extracted the dead fetus from the uterus'."*
>
> —F.B. Lund
> *Boston Med Surg J* 1924; 191:1009

On October 20, 1968, Greece and the Island of Skorpios gained instant fame and recognition when the 39-year-old American widow, Jacqueline Kennedy, married the 62-year-old Greek tycoon Aristotle Onassis. That day in the pouring rain, history came to a standstill. Two different personalities, two different sensitivities, two different backgrounds of people accepted each other. As it brought together new and old, future and past, renaissance and antiquity, it seemed to symbolize the trends of the past, accepting history, blending the Greeks with the new world again. Greece had been the "Cradle of Civilization", and it appeared as if we were remembering those glorious times with the consummation of this ceremony.

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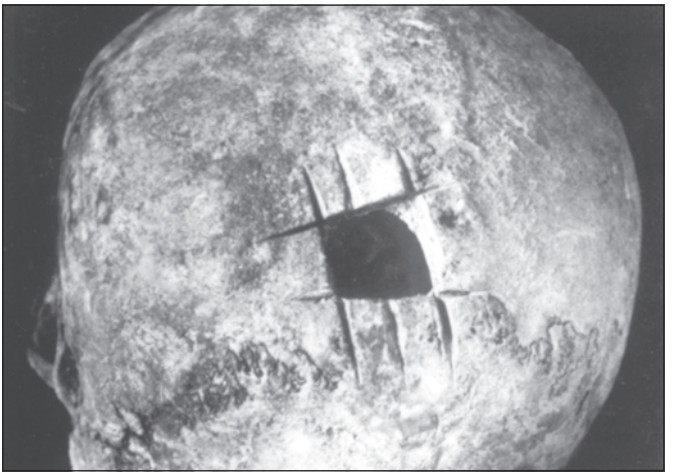

Figure 7.1. Trephined skull encountered in the Judean city of Lachish in the Middle East. The actual time of this operation is not known, but it is possible that it occurred around 1200 B.C.E. since Mesopotamian culture flourished from circa 2300 to circa 1600 B.C.E. (Institute of Archaeology, University of London). (Reproduced from Lyons AS, Petrucelli II RJ. *Medicine: An Illustrated History*. New York: Harry N. Abrams Inc., 1978.)

Ancient Greeks established the foundations of Western thought and combined arts, science, and philosophy to develop a new kind of world–one that would be more educated and respectful of the individual as an individual, of the community as a community, and of the whole society as a group. Medicine and surgery were no exception to the Greeks' extraordinary developments.

Following the golden age of Mesopotamian and Egyptian surgery, the knife changed hands, and the art of surgery remained the property of Western civilization. Once in the possession of the skilled Greeks, surgery swiftly attained a stature that surpassed the Mesopotamians, Egyptians, and other Indoamerican and Middle East groups (Fig. 7.1). Originating around 3500 B.C. from the Aegean island of Crete—the seed from which European civilization germinated—the Greeks developed a rich culture that was friendly towards medical and surgical advancement.

The Minoans of Crete (3500-1100 B.C.) initiated this Greek adventure. They excelled in construction and sea trade, building an intricate palace at Knossos for King Minos. Unfortunately, in the ensuing

centuries, other Greeks from the mainland destroyed the Minoan civilization. Almost simultaneously, late Hellenic culture (1600-1100 B.C.) arose in mainland southern Greece at the City of Mycenae. With their Minoan emphasis of water sanitation, personal hygiene, and physical and mental health, it was not surprising that surgery flourished, as evidenced by the surgical instruments found in a Mycenean tomb dated around 1400 B.C. These instruments included long blades, probes, chisels, needles, scissors, and forceps, as well as a stone grinder to prepare herbal medicines. Unfortunately, despite the wide array of tools discovered, no writings of surgical procedures were left.

In spite of the Myceneans' courageous character, they surrendered to the forces of invading neighboring tribes around 1100 B.C. About this time, the Dorians swept through Greece, mainly across the Peloponnesus, Crete, and southwestern Asia Minor. Years of invasion and migration by this and other groups continued until late 700 B.C. This period of Dorian domination in the south, Aeloian control in the north, and Ionian domination in the northeast, has been called the Dark Ages of Greek culture.

Around 700 B.C., Homer, a gifted Greek thinker and author, created poems, the Iliad and the Odyssey. Ancient Greeks regarded these poems as a great source of moral and practical recommendations. Indeed, they were the very essence of Hellenic unity and heroism as well as the basis for the development of Western literature. The *Iliad*, the oldest surviving Greek poem, explored the heroic ideal within the context of the Trojan War (around 1200 B.C.). This work revolves around Helen, the wife of the king of Sparta, who is taken away to Troy. Agamemnon, brother of the King, goes to her rescue. Achilles, a Greek hero, refuses to fight until Hector kills Patroclus. Achilles then takes the life of Hector, and the story ends with his funeral. The *Odyssey*, another great epic poem, analyzed the deep human emotions surrounding Odysseus, King of Ithaca, after fighting for Greece in the Trojan War and wandering the land for twenty years, he returned home to be recognized only by his dog and nurse. Tradition and design, spontaneity and vision, poetic structure and story amalgamated to produce two incredible epics. The *Iliad* and *Odyssey* went beyond any other tales in that they expressed the triumphs and frustrations of human life.

The medicine (including surgery) practiced during Homer's time is aptly called Homeric medicine. The *Iliad* conveyed one of the world's first accounts of military battlefield trauma. The Homeric surgeon was exposed to extensive trauma surgery that represented

the wounds produced by spear, arrow, slingshot, club, and bow. Henry Sigerist, in his unique *History of Medicine*, referred to 141 instances of wounds cited in the *Iliad*: six in the skull, seven in the forehead, three in the temples, eight in the ears, one each in the eyes, nose and mouth, two in the jaws, six in the throat, 11 in the neck, four in the collarbone, 11 in the chest, 10 in the breast, 23 in the abdomen, nine in the back, 35 in the upper and lower extremities, one in the heart, and two of decapitation. Mortality was extremely high when the wounds were due to spears and sword thrusts. Slingshot and arrow injuries had more favorable outcomes.

Literature tells us that Menelaus, the Spartan King, was wounded in the abdomen by an arrow during the Trojan War. He received treatment from Makaon, the son of Asclepius, the healing god. This incident recognizes the ability of the Homeric surgeon to manage this kind of injury. Makaon extracted the arrow, sucked out the blood, and applied a special preparation—used before Chiron—to aid healing. We do not know if Menelaus survived this event because of the protective effect of his bronzed belt and girdle in attenuating the force of the arrow, or because of the expertise of the army's best surgeon.

In spite of these developments, Greek physicians of the times of Homer did not have a basic knowledge of anatomy, physiology, or pathology. Instead they knew few anatomical terms, mainly those of the exterior parts of the body. Their medicine was based on religious and secular principles, and a great deal of their medical practice originated in mythology.

A classical example of Greek mythology applied to the understanding of disease lies in the cult and legend of Asclepius. Even though he was not born a god, Asclepius was the son of a god (Apollo, and a mortal woman) nymph Coronis. Asclepius was raised by Chiron—great musician, seer and physician. As the preceptor of heroes, Chiron educated Achilles and Asclepius, although Homer only called Asclepius astros (physician), not Achilles. How and why Asclepius became the universal healing god is not clear but, legend recounts the incredible accomplishments of Asclepius. Hades, god of the underworld, complained of the good fortunes of Asclepius to Zeus, who found the concerns justified and killed Asclepius with a thunderbolt. From then on, Asclepius remained as a healing deity, venerated as the Greek god of medicine and surgery. The cult to Asclepius reached its peak in the sixth century B.C. When temples flourished throughout the Hellenic world—most prominently in Epidauros, Pergamon, and Athens.

Figure 7.2. Ancient Greek detail of Achilles bandaging the injuries of Patroclus in a typical battlefield scene, circa 50 B.C.E. (Staalidne Museen, Berlin). (Reproduced from Lyons AS, Petrucelli II RJ. *Medicine: An Illustrated History*. New York: Harry N. Abrams Inc., 1978.)

As Greece emerged from this intensely heroic epoch, the medical community was dominated by the contributions of Asclepius. This celebrated physician from Homeric times was even then recognized as the originator of Greek medicine for his effective treatments and his introduction of sympathetic principles of patient care. Physicians from all over the peninsula flocked to medical clinics where disciples of Asclepius shared their experiences and taught the best medical care for various maladies and wounds (Fig. 7.2). The Greeks, however, did not completely elevate mythology above common life, and they believed gods had a significant number of virtues in common with human beings.

Monuments and sculptures honoring Asclepius' existence have been frequently seen around medical schools, universities and educational

buildings in a great number of cities throughout the land. As Greek culture was accepted, Asclepius was widely embraced with great zeal, and more than 400 temples of worship, recreation, and healing were created in his name. In addition, a new medical philosophy that incorporated Asclepius' ideas, began to emerge enlightening Greece and the whole world.

Asclepian medicine was practiced in the temples by priests—referred to in this role as asclepiads, and outside the temples as secular physicians. Asclepius was their patron and supporter, "he was the blameless physician of old praised by Homer". He protected the physicians, and in turn they treated their patients with thoughtfulness and care. In regards to surgery, according to distinguished professor Haeger, Asclepiads only conducted incisions of abscesses and boils.

Asclepian medicine progressed almost concurrently with the bright outlook of a sophisticated group of philosophers—the pre-Socratic philosophers, who began to challenge the mystic origin of disease. They did not offer significant contributions to medicine or surgery but carefully reflected on the nature of various phenomena. They presented reasoning as a way to understand the world and its functions. Mythology and the transcendental were marginalized. Everything had a cause, including the origin of earth. The use of these principles in the study of disease enormously benefited the essence of medicine.

Three Milesian philosophers—Thales, Anaximander and Anaximenes—provided the most critical appraisal of the universe. Thales (around 585 B.C.), a practical philosopher and the first European, believed that water was the origin of life. Anaximander (around 560 B.C.) speculated that more than one element was present at the origin of the world: water, earth, fire and air. Anaximenes (around 546 B.C.) returned to accept one element—air was the primary cause of all things. According to Sigerist, these three generations of philosopher-scientists laid the foundation of Western philosophy and Western science. "They observed phenomena, reasoned about them, and in doing so developed methods that could be applied also in the investigation of health and disease."

The next influential philosopher was Pythagoras of Samos (around 530 B.C.), who stimulated mysticism as well as science. He believed in perfect balance as the goal of harmonious life. Harmony was a mathematical proportion, and numbers were the most important principle of Pythagorean life. The significance of these developments for medicine was readily apparent. Health equaled equilibrium, and

to maintain this status one had to practice moderation and reach equanimity in all circumstances. Surgery was not recommended because it interfered with the soul. Another philosopher, Heraclitus of Ephesus (around 500 B.C.) considered everything in constant flux, with nothing unchanged. The world was not static but dynamic, and the primary element of unity was fire.

From the seventh to the sixth century B.C., Cnidos represented one of the most important centers of medical knowledge. The Cnidians, early in time, recognized the significance of observation in medical practice. They completely substituted theurgical medicine for a more rational approach in the origin and understanding of disease. The extent of their surgical practice is not well known, even though they likely performed minor surgical procedures.

From 700 B.C. to the beginning of the Classic Period in 461 B.C., Greece entered an era of colonization of its overseas neighbors and successfully resolved the Persian attacks by Darius I and his son Xerxes. The Athenian victory at Salamis completely eliminated Persian ambitions of conquering Greece and, therefore, the opportunity to change the history of Western civilization.

Approaching the fifth century B.C., the splendor of Greece had reached its highest point. Athens was the center of the world. Pericles, who came to power in 461 B.C., made Athens the intellectual and artistic exemplar of Greece. Architecture, painting, sculpture, drama, and philosophy abundantly flourished. This period was considered the Golden Age of Athens or the Age of Pericles. During this time, Cos, a small Aegean island, began to grow in medical stature. In just a few years, it would become the greatest center of medicine that the Greek ancient world would ever see.

Hippocrates (460-377 B.C.), who would later ascent to the title of "The Father of Medicine," was born on the island of Cos. His contemporaries in the Greek world included Socrates, Herodotus, Thycydides, Sophocles, and Euripides, among others. While each of these men were leading and enriching their respective fields, Hippocrates was also making extensive contributions which culminated in 72 medical works known as the *Corpus Hippocratum*. It is believed that other physicians, in addition to Hippocrates, were instrumental in compiling these works. However, regardless of the treatise's authorship, it is believed that Hippocrates' understanding of surgery was extensive and clear. He gave advice as to the operator's comfort, behavior, and hygiene, as well as the surgical roles of various instruments, assistants, and lighting techniques.

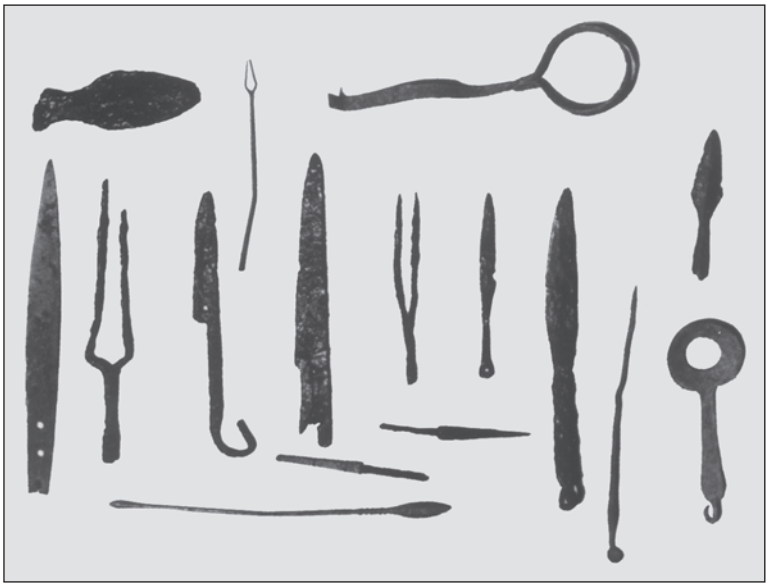

Figure 7.3. Ancient Greek surgical instruments, most likely from Hippocratic times, circa 400 B.C.E. (Epidauros Archeological Museum) (reproduced from Lyons AS, Petrucelli II RJ. *Medicine: An Illustrated History*. New York: Harry N. Abrams Inc., 1978).

Hippocrates represented the essence of a new kind of medicine and surgery. He laid the foundation for the development of scientific medicine. Likewise, he believed in a rational and practical approach to solving surgical problems (Fig. 7.3). His ideas were very specific as evidenced by the writings conveyed through the *Corpus Hippocratum*. It would be difficult to paraphrase each one of his concepts and still offer the details of his principles in the care of the surgical patient. In this regard, we should let the master or his disciples tell us the story.

For the Hippocratic surgeon, it was important to appreciate all the various conditions of disease, using all of the senses. Hippocrates' capability to recognize certain surgical problems was based in his accurate observation. Let us hear from his original writings:

> *On the Surgery*
> *"It is the business of the physician to know, in the first place, things similar and things dissimilar; those connected with things most important, most easily known, and anywise known; which are to be seen, touched, and heard; which are to be perceived*

in the sight, and the touch, and the hearing, and the nose, and the tongue, and the understanding; which are to be known by all means we know other things."

As to the important elements of surgery, these early surgeons were quite precise regarding fundamental needs. There were no doubts as to the most significant elements:

"The things relating to surgery, are—the patient; the operator; the assistants; the instruments; the light, where and how; how many things, and how; where the body and the instruments; the time; the manner; the place."

The Hippocratics defined in more detail the importance of acceptable lighting in the performance of the operative act. Observation being so critical for these surgeons, it required certain elements in their working conditions for appropriate viewing:

"The operator is either sitting or standing, conveniently for himself, for the person operated upon, for the light. There are two kinds of light, the common and the artificial; the common is not at our disposal, the artificial is at our disposal…the part that is operated upon should be opposite the light, and the operator opposite the part operated upon, except in so far as he does not stand in his own light; for in this case the operator will indeed see, but the thing operated upon will not be seen."

Now, as the surgeon progresses in the realization of his act, attention is directed towards elements of comfort and appropriate body position. It is well known today that surgeon and patient both benefit from good position:

"With regard to himself: when sitting, his feet should be raised to a direct line with his knees, and nearly in contact with one another; the knees a little higher than the groins, and at some distance from one another, for the elbows to rest upon them…With regard to the part operated upon; we have to consider how far distant, and how near, above, below, on this side, on that side, or in the middle. The measure as to distance and proximity is, that the elbows do not press the knees before, not the sides being; that the hands be not raised higher than the breasts, nor lower than so as that when the breast reposes on the knees he may have the hands at right angles with the arm…When standing, he must make his inspection, resting

firmly and equally on both feet; but he must operate while supporting himself upon either leg, and not the one on the same side with the hand which he makes use of; the knee being raised to the height of the groins as while sitting; and the other measures in like manner."

The dexterity of the surgeon remained a point of great interest to these Greek physicians. Elements of practice were encouraged as well as the physical condition of the various parts of the hand:

"The nails should be neither longer nor shorter than the points of the fingers; and the surgeon should practice with the extremities of the fingers, the index-finger being usually turned to the thumb; when using the entire hand, it should be prone; when both hands, they should be opposed to one another. It greatly promotes a dexterous use of the fingers when the space between them is large, and when the thumb is opposed to the index."

The role of instruments in surgery was of paramount importance to the Hippocratic surgeon. Characteristics of their use were presented as the key aspect in the progression of the surgical event:

"The instruments, and when and how they should be prepared, will be treated of afterwards; so that they may not impede the work, and that there may be no difficulty in taking hold of them, with the part of the body which operates."

The surgeon in Hippocrates' times paid dedicated attention to the management of wounds. He classified the wounds as dry and moist and added prognosis to their evolution and treatment. He recognized the importance of draining harmful substances that needed to be excreted to improve healing.

On Wounds
"No wounds should be moistened with anything except wine unless the wound is in a joint. Because dryness is more nearly a condition of health, and moisture more nearly allied to disease. A wound in moist and healthy tissue is dry. It is better to leave a wound unbandaged, unless a cataplasm is applied. Certain wounds ought not to have cataplasms applied. Fresh wounds are less suitable for cataplasms than old ones, and wounds in the joints…Standing erect does the most harm, especially if the leg is the wounded part. Patients ought neither

to walk about, or even be allowed the sitting position. Rest and quiet do the most good. Recent wounds, as well as the surrounding parts, will be less liable to inflammation, if one can induce suppuration as soon as possible, and not let the pus be blocked up in the opening of the wound, or if one can bring it about that it does not suppurate at all, except the little pus that necessarily appears, but keep it dry with some remedy that is not too harsh. For it is dried to excess fever will come on, as indicated by chills and throbbing. For the wounds become inflamed when they are going to suppurate on account of the alteration and heating of the blood, till it softens and pus appears, in wounds of this sort at least. When you decide that a cataplasm is indicated, do not apply it to the wound, but to the surrounding parts, so that the pus may have free exit, and the tissues which are hardened rendered soft."

The Hippocratic surgeon continued to emphasize the role of suppuration in inflammation and wound care. The harmful effect of other substances, such as oil, occupied a great part of his concerns:

"When the flesh has been lacerated and contused by the weapon, the wound should be treated in such a way as to produce suppuration as quickly as possible. Because (if this is done) it will be less inflamed and the tissues which have been contused and lacerated and putrid and purulent have to soften and come away. After that new tissue sprouts up…It helps after the escape of the blood to bandage over such wounds a piece of sponge, soft and thick, and cut to the appropriate size, preferably dry, rather than moist, or to place leaves of delicate texture over the sponge. Oil or softening or greasy remedies are not good for fresh wounds either, neither are greasy or fatty remedies good for them especially when the wound needs a lot of cleansing."

Here, this surgeon expressed his meticulous technique of applying ointments in a dry wound. He also drew attention to the effects of weather and wound location in the healing process. Moreover, he included the negative actions of inflammation and hematoma formation in wound recovery:

"…But when you decide to bandage, do not smear on the ointment before you have thoroughly dried out the wound, then put it on; but sponge out the wound many times with a sponge, dry it with a clean dry fine linen cloth applying it

many times. Having applied in this way the remedy which you think will be useful, either bandage it or not, as seems best. For most wounds warm weather is more favorable than winter except those in the head and abdomen… These in which the wound is surrounded by inflammation do not heal until the inflammation has ceased, nor are wounds likely to heal, in case the surrounding parts are blackened either from softened blood, or blood supplied by an adjoining varicosty and they won't heal at all until you get the surrounding parts into a healthy condition."

Hippocrates and his group put forward a classical description of empyema (pus in the chest cavity) and its surgical treatment. Without missing a detail, they offered a clear analysis of the surgeon's role in this particular pathology. Previously, no one else had presented such a lucid description of a medical condition and the best treatment for it. Their treatment continues today to be the gold standard in the management of empyema, treatment that reflects the most rational approach to patient care. A treatment that is universally effective. Let us follow what they said:

Operation for Empyema
"When the duration of the disease becomes longer, the fever is severe and the cough is increasing, and the side is painful, and he cannot bear to lie upon the well side, but has to lie on the side of the disease, then the feet swell, and the hollows of the eyes. When the fifteenth day after the rupture arrives give him a profuse bath of hot water, sit him in a firm seat that he may not move, let an assistant hold his hands, while you shake his shoulder and listen to hear which side the pus makes a splash. Hope it is on the left so that you can make your incision on that side, for it is less deadly. If on account of the thickness of the tissues and the fulness of the cavity it does not give out a sound, so that you cannot make out where it is, which sometimes occurs, make an incision on the side which is more swollen and painful, rather below and behind the swollen part, so that an easy outlet may be afforded for the pus. First incise the skin between the ribs with a broad knife, then wind the blade of the knife with a strip of linen leaving out the point to the breadth of a thumb nail, and push it in. Then when you have let out as much pus as you think best, stuff the wound with a drain of raw flax to which a thread is attached. Let out the pus

once each day. On the tenth day when you have let out all the pus dress it with fine linen. Then introduce through a small tube a mixture of oil and wine, warm, so that the lung which has gotten used to the moisture of pus may not be suddenly dried. Draw out the liquid which has been injected at night in the morning, and that injected in the morning at night. When the pus becomes thin like eater, and feels slippery to the finger and is small in quantity put in a hollow tin tent. When the cavity is entirely dry, cut off the drains a little at a time and allow the incision to heal, till you take out the drain. An indication that the patient will recover: if the pus is white, clear, and has fibers of blood (like blood clot?) They generally get well. If on the first day the discharge is the color of egg yolk, and in the next thin and greenish with a bad odor, they die when the pus has run out."

Hippocratic surgeons knew a great deal about bone fractures and their most advanced physiological treatment. They described an innovative management to aid in the healing of these injuries:

Fracture of the Arm
"When the arm is broken…the best plan is to put round the arm a broad and soft skin, or broad shawl, and to hang some great weight to it, so as to produce moderate extension; or otherwise, while the arm is in the position I have described, a strong man is to take hold of it at the elbow and pull it downward. But the physician standing erect, must perform the proper manipulation, having the one foot on some pretty high object, and adjusting the bone with the palms of his hands; and it will readily be adjusted, for the extension is good if properly applied. Then let him bind the arm, commencing at the fracture, and do otherwise as directed above; let him put the same questions and avail himself of the same signs to ascertain whether the arm be moderately tight or not; and every third day let him bind it anew and make it tighter; and on the seventh or ninth day let him bind it up with splints, and leave it so until after the lapse of more than thirty days. And if he suspect that the bone is not lying properly, let him remove the bandages in the interval, and having adjusted the arm, let him bind it up again. The bone of the arm is generally consolidated in forty days. When these are past, the dressing is to be removed, and fewer and slacker bandages applied instead

of it…and we must form our judgement of it from the swelling in the hand, looking also to the strength of the patient."

Once more, Hippocratic surgeons moved far ahead of the reach of ancient medicine. Understanding the evolution and neuromuscular physiology of dislocations, they advanced the most appropriate and rational treatment for dislocations of the hip. Consequently, another classical account ensued from their significant knowledge. As in their contributions to the treatment of empyema, they established a treatment that was universally accepted and praised until the twentieth century. Let us follow again, the full report of their writings:

On Dislocations of the Hip
"There are four modes of dislocation at the hip-joint: of which modes, dislocation inward takes place most frequently, outward, the most frequently of all the other modes; and it sometimes takes place backward and forward, but seldom. When, therefore, dislocation takes place inward, the leg appears longer than natural, when compared with the other leg, for two reasons truly; for the bone which articulates with the hip-joint is carried from above down to the ischium where it rises up to the pubes, upon it, then, the head of the femur rests, and the neck of the femur is lodged in the cotyloid foramen…The buttock appears hollow externally, from the head of the thigh-bone having shifted inward, and the extremity of the femur at the knee is turned outward, and the leg and foot in like manner. The foot then being turned outward, physicians, from ignorance, bring the sound leg to it and not it to the sound leg; on this account, the injured limb appears to be much longer than the sound one, and in many other cases similar circumstances lead to error in judgement…

When the head of the femur is dislocated outward, the limb in these cases, when compared with the other, appears shortened, and this is natural, for the head of the femur no longer rests on a bone as in dislocation inward, but along the side of a bone which naturally inclines to the side, and it is lodged in flesh of a pulpy and yielding nature, and on that account it appears more shortened. Inwardly, the thigh about the perineum appears more hollow and flabby, but externally the buttock is more rounded, from the head of the thigh having slipped outward, but the nates appear to be raised up, owing to the flesh

there having yielded to the head of the thigh-bone; but the extremity of the thigh-bone, at the knee appears to be turned inward, and the leg and foot in like manner, neither the symptoms of dislocation outward.

Dislocation inward at the hip-joint is to be reduced in the following manner… The patient is to be suspended by the feet from a cross-beam with a strong, soft, and broad cord; the feet are to be about four inches or less from one another; and a broad and soft leather collar connected with the cross-beam is to be put on above the knees; and the affected leg should be so extended as to be two inches longer than the other; the head should be about two cubits from the ground, or a little more or less; and the arms should be stretched along the sides, and bound with something soft; all these preparations should be made while he is lying on his back, so that he may be suspended for as short a time as possible. But when the patient is suspended, a person properly instructed and not weak, having introduced his arm between his thighs, is to place his fore-arm between the perineum and the dislocated head of the os femoris; and then having joined the other hand to the one thus passed through the thighs, he is to stand by the side of the suspended patient, and suddenly suspend and swing himself in the air as perpendicularly as possible. This method comprises all the conditions which are natural…"

The Corpus writings suggest that the Hippocratic surgeons recognized and treated five types of cranial injuries: contusions without fracture or depression, simple fractures, fractures of the outer table alone, depressed fractures, and *contrecoup* fractures. Trephination was performed most frequently for depressed fractures. Furthermore, *seton* ligatures were described for the cure of *fistula-in-ano*. Cauterization for the relief of hemorrhoids was repeatedly mentioned. Hemorrhage was controlled by tamponade or compression; however, there was no evidence of the use of vessel ligatures. Additionally, several surgical historians have alluded to the fact that limb amputations, bladder stones, and inguinal hernias were conspicuously absent from the *Corpus* writings.

Hippocrates' revolutionary methods of wound care were equally significant in that they encompassed the use of alcoholic substances to prevent infection and associated swelling. His procedures, stressing both cleanliness and the drainage of pus, were essential steps in

reducing infectious disease. Hippocrates also developed the brilliant methods previously described, that is, the management of fractures and dislocations still in use today. When these scientific accomplishments were combined with Hippocrates' strong ethical and humanistic spirit, it is easy to see why his influence has transcended surgery.

The greatness of Hippocrates, according to Haeger, lies on a level beyond diagnosis, prognosis, or treatment. Indeed, he established the basis for modern medical ethics. Hippocrates preached a credo that he always followed: be a good doctor and a good human being. However, his enormous impact was not felt outside the region until his works were published in Alexandria several centuries later.

As the Greek classical period ended with the defeat and fall of Athens in 404 B.C., Sparta claimed supremacy following its victory in the Peloponnesian War. Spartan rule did not last because of internal dissatisfaction due to poor governance. In 371 B.C., the Thebans defeated the Spartans at Leuctra. In spite of this insecure climate and a period of decay, Athens remained the cultural leader. Aristotle, Plato, Demosthenes, and other great thinkers continued to demonstrate the intellectual power of Greece.

Aristotle's science and influence (384-322 B.C.) dominated the fourth century B.C. Born at Stagira in Thrace (Macedonia), he studied under Plato in his late teens. After his master's death, he traveled around the area for 12 years. In 334 B.C., when his disciple, Alexander the Great, became a King, Aristotle returned to Athens. Better known as a creative thinker than a true physician, Aristotle contributed greatly to the field of comparative anatomy, as well as to the Greek philosophical tradition. He founded the Lyceum, which concentrated on the study of history and biology, and instructed leading Greek physicians, including Praxagoras of Cos, Diocles of Karystos, and Theophrastos of Eresos. His school of thought was called the Peripatetic School (from peripatos, the garden in which the students and teachers held their discussions). The Peripatetics did little to advance the cause of surgery, and Aristotle concentrated more on research and teaching of comparative anatomy than on practical medicine. His writings on zoology and anatomy were legendary, and he described the performance of dissections throughout his work.

From 334-323 B.C., Alexander the Great reigned over Greece and its provinces, and was a dedicated promoter of Greek civilization. He developed Greek cities throughout the region, including Alexandria in Egypt. Alexander disseminated Greek culture and positively influenced the history of the world. At his death in 323

B.C., the Hellenistic Age began, which lasted well into the Roman Empire and the first centuries of our era.

By the end of the third century B.C., the Alexandria School reached the "centre of the scientific world." The city of Alexandria in Egypt accumulated a large number of scientists who gathered around a premier library and museum. It was here that free spirit and opportunity became the engines for progress in the Western world. Under these conditions, anatomy flourished as a "recognized discipline". Two men in particular brought to Alexandria the attention of civilization. Herophilus of Chalcedon (around 300 B.C.) and Erasistratus of Keos (330-250 B.C.) established themselves as the premier surgeon-scientists of their times. Both distinguished themselves with significant achievements and discoveries in anatomy and physiology, respectively.

Herophilus, considered the "Father of Anatomy," was "the first to dissect both human and animal bodies," according to Galen. Charles Singer, dedicated student of the anatomy and physiology of the Greeks, challenged this notion, since he encountered evidence of dissection at earlier dates, such as the case of Diocles. In this regard, he believed Galen was referring to public dissection, which Herophilus was the first to practice.

A disciple of Praxagoras and the Coan school, Herophilus made significant contributions to the field of anatomy. He described with precision the central nervous system, including its surrounding structures, such as the meninges, the fourth ventricle, and the cranial nerves. He separated the nerves into motor and sensory, according to their function. He opposed the view of Aristotle, that the heart was the center of the body. Instead, he believed that the brain was the primary organ of the economy as well as "the seat of the intelligence." The Alexandrian physician extended his knowledge to the liver, pancreas, and salivary glands and coined the name for the duodenum. Also, he described the lacteals (lymphatics) and distinguished between arteries and veins. "He is the acknowledged founder of anatomy."

Erasistratus, considered the "Father of Physiology," was the first to indicate that every organ had a grouping with each of three structures vein, artery, and nerve. He noted that these elements subdivided several times until they reached very minute proportions, and that all of these "vessels" made up the tissues. Additionally, minute tubes formed part of the "vessels" through which these tissues were nourished. Singer elegantly described the accomplishments and principles on which

Erasistratus theories rested. The pneuma (the vital spirit and the animal spirit) represented the basic tenets of Erasistratus concepts. Let the noted historian Charles Singer decipher those concepts:

> *"Blood and two kinds of pneuma are the essential sources of nourishment and movement. The blood is carried by veins. Air, on the other hand, is taken in by the lungs and passes to the heart, where it becomes changed into a peculiar* ***pneuma****, the* ***vital spirit****, which is sent to the various parts of the body by the arteries. This spirit is carried to the brain, where it is further changed, apparently in the ventricles, to a second kind of* ***pneuma****, the* ***animal spirit****. The animal spirit is conveyed to different parts of the body by the nerves, which are hollow."*

Erasistratus confirmed the findings of Herophilus in regard to the central nervous system. He distinguished between the brain and cerebellum, described the brain ventricles and meninges, noted the convolutions, and traced the nerves into "brain substance." Erasistratus separated the function of the nerves into motor and sensory agreeing with Herophilus.

Erasistratus, a disciple of the Cnidian school, did a large number of dissections in newly born goats, and observed the lacteals (lymphatics) like Herophilus, and carefully studied the circulation. He conceived the heart to be the source of arteries and veins, matter that, according to Singer, kept Erasistratus not only ahead of his time but also ahead of all conventional opinion until Harvey.

Erasistratus discovered the "very fine intercommunications between the two types of vessel" (arteries and veins), introducing in this way the capillary system. He conceived the right ventricle of the heart filled with blood and the left ventricle with vital spirit. "During diastole blood was drawn into the right ventricle and pneuma into the left ventricle, and these were expelled during systole." He named and described the function of the tricuspid valve. He recognized and studied other vessels, such as the aorta, pulmonary artery, intercostals, hepatic, renal, and gastric arteries, as well as the pulmonary veins, vena cava, azygos, and hepatic veins. In another area, Erasistratus drained empyemas and developed some abdominal operations and a catheter for drainage.

Although it lasted for several centuries, this boom of medical knowledge was not destined to remain in Greece. No evidence of the same great medical practices and advances achieved by their ancestors is seen today. During our century, and even several centuries

before us, Greece has not excelled in medicine; in fact, its position has been relegated to the level of the underdeveloped nations. Since their classic period, in which they gave abundantly to the rest of the world, the Greeks have faded from medical prominence. Now, we must await for future generations to expand the use of the knife throughout the rest of the world.

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CHAPTER 8

Early Roman Times before Galen

Following Greek Principles: The Greco-Roman Knife

> *"Technical competence in surgery became better as new shapes were devised for medical tools, and as new metals and alloys were found to provide sharper edges and cheaper equipment…His experience in surgery gave him a good knowledge of superficial anatomy, particularly musculature of arms and legs. Surgery was highly refined as long as the patient had courage and the doctor had good tools and experience, and the head and the abdomen were not involved. A cursory reading of Celsus' summary of surgical techniques as they existed in the first century shows sense and firm purpose, as well as a reasonably sure knowledge of human anatomy."*
>
> —J. Scarborough
> *Roman Medicine* 1969; 83

The *Terme di Caracalla*, a grandiose reminder of ancient Rome, was the world center of attention again when the supreme tenors—Carrera, Domingo, and Pavarotti—had their opera extravaganza on July 7, 1990 as the major celebration of the Soccer World Cup in Rome, the "Eternal City". What an encounter of modern musical giants in such an overwhelming shrine of the past. What a demonstration of cultural grace for such a place of emperors. What an extraordinary setting for the once flourishing but now dormant Roman knife.

It is unknown precisely when Rome was founded, but legend marks the date as 753 B.C. when Romulus and Remus founded the city. Seven kings ruled early Rome before the Etruscans dominated this territory in the late 500s B.C. and brought with them progressive

Origins of the Knife: Early Encounters with the History of Surgery,
edited by Luis Horacio Toledo-Pereyra. ©2006 Landes Bioscience.

concepts in architecture, engineering, and the arts. Once the Etruscans had been defeated, the Romans established their republic in 509 B.C., which lasted—Punic War after Punic War—until 27 B.C., when Augustus became the first Roman emperor. From this time until the death of Constantine in 337 A.D., the Romans enjoyed a long period of material and intellectual growth.

The Roman Empire included a vast area extending from northern Britain to the shores of the Red Sea and the Persian Gulf. Through military warfare, the Romans acquired an extensive geographical base. They dominated large areas of natural resources, including good farming, fishing, minerals, and forests. They ruled all the lands around the Mediterranean Sea, or *Mare Nostrum*. "All roads led to Rome", as Rome was indeed the center of the world.

As Rome was dominated by Etruscans during part of the seventh and sixth centuries B.C., religion represented the basis upon which Roman medicine was built. The gods gave disease and then eventually took it away. Roman medicine was based only on folk traditions, and its magical basis was more rational or quasi-religious than irrational. The presence of malaria, typhus, and anthrax or any number of other infections had only religious origins. Physicians in ancient Rome did not attempt to understand the natural history of disease. Early Romans did not believe physicians existed as a separate profession but accepted that old citizens practiced medicine on their own. Under these conditions surgeons had nowhere to practice, solely because this branch of medicine was not considered separately among early Romans.

The Etruscans showed early Romans some of their ideas and beliefs in the practice of medicine and their understanding of anatomy. The Romans adapted divination to the development of their art. Recipes and remedies in the form of chants and symbolic actions were practiced daily on Roman soil.

Human anatomy, particularly in relation to the liver and its segments, connections, anomalies, etc., was extensively explored by Etrusco-Roman priests and artists. A clear proof of their interest is reflected in the famous bronze liver encountered at Piacenza around the last third of the nineteenth century (1877). In ancient Rome, important questions about people's lives were written in tablets and placed at the feet of gods. An animal, such as a sheep, would then be slaughtered, and the abdominal cavity opened by a priest who specialized in reading livers. The questions would be answered and the rest of the abdominal organs examined. The priest would then proceed to excise the liver, and study with extraordinary care the

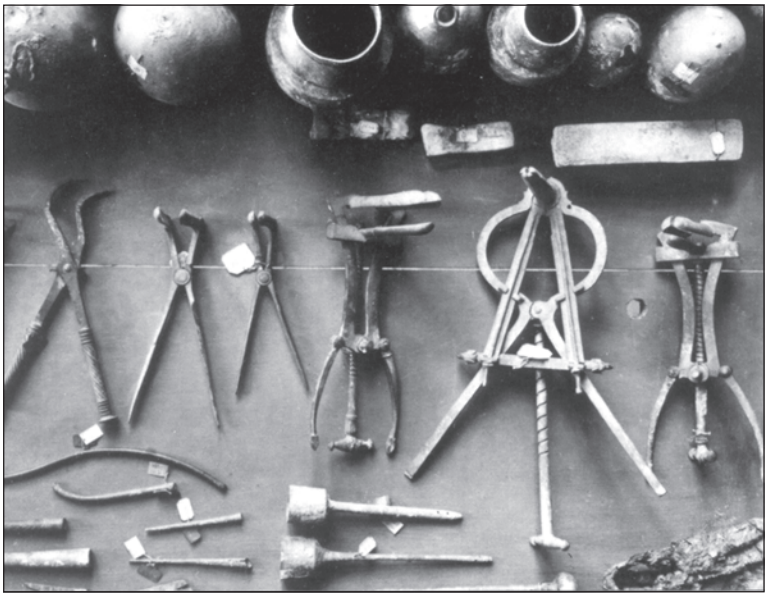

Figure 8.1. Ancient Greco-Roman surgical instruments (Museo Archeologico Nazionale, Naples) (reproduced from Lyons AS, Petrucelli II RJ. *Medicine: An Illustrated History*. New York: Harry N. Abrams Inc., 1978).

whole liver, including the left and right lobes, the square and caudatus lobes, the processus capillaries and processus pyramidalis, the bile ducts, gallbladder, and blood and lymphatic supply. Complete texts were organized around liver anatomical structures, the complicated are of liver reading and the ceremonial details associated with it. Some of these ideas of liver reading were not unique to the Estruscans, as Assyrians and Babylonians had previously utilized similar concepts in the ancient near east.

Scarborough, in his excellent treatise *Roman Medicine*, considers when quoting Tabanelli that there is some evidence that Etruscan surgeons and dentists had nearly mastered their art even before the Hellenistic world entered Rome. However, the specific surgical procedures performed by the Etruscans are not clearly understood. The surgical instruments found at Pompeii and Herculaneum appear to be more of Etruscan design then Greek development. These included scalpels, flat probes, tissue forceps, surgical scissors, spatulas, and bone levers (Fig. 8.1). If the origin of these instruments could be placed

exactly on a timeline, we could then suggest multiple corresponding procedures that could have been performed in those times. Since a definitive timeline is unknown, historians can only approximate the availability of these instruments within a time span ranging from the Etruscan, Greek, and Greek-Roman periods, that is, from the seventh, fourth, and second centuries B.C. Therefore, estimating the introduction of surgery based on Etruscan principles, into Roman territory cannot be strongly sustained when we consider the current evidence. Roman surgery, thus, as unsophisticated as it was in early times, appears to have been more influenced by the Greek world. This is particularly true in later times when Greek modes of treatment filtered through Etruria in route to Rome.

After Rome eliminated the Etruscans and the Republic was established, "Greek gods soon arrived to take up residence at Rome, too." Romans were clearly aware of the extraordinary strengths of the deities of the Hellenistic world of medicine. When yet another terrible plague erupted in the fifth century B.C., a temple was built to the Greek god Ascelepius on the Tiber River outside of Rome because official suspicion of non-Roman gods still existed. A successful taming of the plague resulted in widespread acceptance of Greek gods. "The introduction of Asclepius is the first event of (Greek) medical history in Rome."

The fifth and fourth centuries B.C. highlighted the sophistication of Hellenistic medicine in the world. Even though Hellenistic medicine included religious and magical concepts like any other medicine of antiquity, rational approaches dominated thought, particularly among the educated Greeks. (Interestingly, this "Hippocratic rationalism" was not nearly as prevalent in the uneducated, common Greek of the time.) The Hippocratic Corpus showed us, in a previous chapter, the wonders of Greek medical sciences, particularly their incredible "genius of synthesis and organization of systems." Contrarily, Roman doctors had not seen medicine in the same way as their Greek counterparts, and a generalized organizational system has not yet emerged into Roman society. But time would reveal that the considerably advanced medical system of the Greeks was going to affect the practice of Roman medicine and surgery forever.[1-18]

A few centuries before the Christian era, Cos, Pergamon, and Alexandria were the most revered medical centers of the Hellenistic world. If a doctor wanted to have solid principles and good practical experience, he was required to attend these centers of excellence.

Acceptance into the physicians' craft associations was primarily based on the medical training received at these schools. The foundation of the Alexandrian library and museum placed "erudition and criticism" at center stage. Physicians could find in these centers of knowledge the most important texts of major Greek authors. The possible opportunities, then, for expanding their expertise through the written word were unique. Ancient physicians had for the first time a specialized library that contained the most extensive collection of manuscripts, scrolls, and medical writings ever accumulated in any one place.

From Hippocrates to Praxagoras to Herophilus and Erasistratus, Romans were about to receive the essence of Hellenistic medical thought. They accepted Greek ideas and philosophy more than that of any other culture of the world. The Romans inherited the Hellenization process, incorporating it into their own practices, and thus emerged a Greco-Roman pattern of life and medicine. From these lands, the writings of Celsus and the extraordinary works of Galen were about to leave an indelible mark on the history of medicine and surgery.

As one wanders through the cobble streets of Rome, it is not hard to imagine the splendor of early times in this magical city. Everything appears to be related to history. The *Colosseo Romano*, the Palatino Hills—where Romulo and Remus founded Rome, according to the well-known fable—the Arch of Constantine, and the Roman Forum are all jewels of ancient architecture. It would not be hard to believe that Roman surgeons had advanced procedures which allowed them to solve some of the routine surgical problems of the times. What were those procedures and how did Roman physicians reach appropriate levels of knowledge in clinical surgery?

The influence of Greek medicine reached a scientifically sluggish Rome though the empire was flourishing in culture and political stature. Some [like Pliny the Elder (23-79 A.D.), Roman encyclopedist] proposed that before Greek medical principles and thoughts entered Rome, the practice of medicine and subsequently surgery was not systematically accepted by Romans. Pliny even considered that doctors did not exist in Roman society before Hellenization occurred. Others, such as Scarborough, recognized that surgical practice in the Roman army, during the Republic legion days, did not contain any medical or surgical doctors dedicated to the physical well-being of the soldiers. Instead, "the soldiers themselves, or the consul, who were deemed skilled in their primitive care," were the providers of

health to the injured military men. The function of the legion was to win battles, not to care for the wounded.

When the Roman legions learned about the methods used by the Greek phalanxes, they adopted procedures similar to the ones already well-known to the Hellenistic world. A Roman physician began to accompany the general on the battlefield providing some needed help in the care of the embattled men. The medical equipment consisted of drugs and some surgical tools. The general would function as the surgeon, dressing and caring for wounds, and the physician would assist him and administer the drugs. On occasion, the physician would act as surgeon if the general requested his help, and others in the unit, such as the camp prefect or the most experienced soldier, could provide similar services.

As Greek influence upon Roman ways of medical practice increased, the role of the surgeon was better understood (Fig. 8.2). During the time of the Empire, physicians practicing surgery had a more defined job in the overall care of the surgical patient, whether that patient was a soldier or not. Although the field of surgery was not clearly separated from other medical matters, there were those who attended mostly to surgically-related problems. The position and representation of the surgeon gradually became more visible within the Greco-Roman lands. First, Celsus through his writings, and later on, Galen with his surgical principles and methods of direct clinical application both profoundly escalated the understanding and practice of surgery in the western world.

Current sources, as well as those of Pliny the Elder, tell us that the first Greek physician to come to Rome and be appointed as an active doctor in the Hellenistic tradition was Archagathus of Sparta in 219 B.C. He was well received and even then considered to be an extraordinary surgeon. Archagathus demonstrated the virtues of surgery and attended very difficult cases that required a significant knowledge of anatomy as well as (a great deal of) experience. But, Archagathus pressed his luck too far when he took on even more complicated cases, which ended in failure. Romans would not accept these results, and Archagathus and his medical associates were banished from Rome. Cato the Censor (234-149 B.C.), a notable Latin writer—encouraged and promoted this same sentiment towards Greek doctors. Pliny himself had indicated that Romans who studied medicine were "mercenary deserters to the Greeks."

But the climate of Roman antipathy changed, and, three generations later, Greek physicians were again returning to Rome. Of great

Figure 8.2. Pompeiian fresco depicting Iapyx removing an arrow from the Trojan hero Aeneas's thigh (Museo Archeologico Nazionale, Naples) (reproduced from Lyons AS, Petrucelli II RJ. *Medicine: An Illustrated History*. New York: Harry N. Abrams Inc., 1978).

importance was the arrival of Asclepiades of Bithynia (120-70 B.C.) into Roman territory around the 90s B.C. Asclepiades arrived as a

distinguished rhetorician and future surgeon, bringing with him an increasingly positive image for this field of medicine. Clearly aware of Hippocratic precepts, he chose not to subscribe to them, but rather to the atomist theory of disease. According to this theory, everything could be explained as an upset of the balance of small particles (atoms) in the body. Therapy was developed to modify the size of the pores, through which the atoms would find their way. Asclepiades rejected humoral pathology and complicated theories for more practical approaches. Thus, he developed a new medical doctrine of thought called methodism, which had an extensive following decades after his death.

Asclepiades had considerable eloquence and charm. He was a physician of the upper class, a society doctor, and his friends were notable citizens of Rome: Cicero, Lucius Crassus, Lucretius, and Marcus Antonius. According to Rutkow, Asclepiades was credited with being the first to propose laryngotomy or tracheostomy in his surgical practice. In addition, his tempered reasoning, understanding of Roman medical practices, and sound therapeutic approach allowed him to overcome the existing animosity toward Greek doctors. Jackson—dedicated student of Roman medicine—believes that "it was Asclepiades' moderation of Greek medical thought combined with the empathy he had with his Roman patients that ultimately ensured not only his own success but also the acceptance of Greek doctors and medicine in the Roman Empire."

Themison of Laodicia and Thessalus of Tralles (who lived around 50 B.C. and 60 A.D., respectively) represented the major followers of Asclepiades of Bithynia. They redefined and transformed the concepts of the methodist school as one of "the most influential systems for centuries ahead." Thessalus thought surgery was limited to the removal of foreign bodies, fractures and dislocations, the incision of tumors or abscesses, and treatment of ulcers. Obviously, this simplistic understanding and approach to surgery did not improve a great deal the figure of the surgeon or the acceptance of his craft among Romans. Around this time, a surgical encyclopedist and erudite Roman philosopher, Aulus Cornelius Celsus (25 B.C.-50 A.D.), was in the process of writing one of the great medical books of antiquity, *De Medicina*, which brilliantly summarized, explained and enhanced the role and methods of all the important surgeons of the past.

Aulus Cornelius Celsus was a nobleman who lived at the height of Roman civilization—during the reign of Tiberius Cesar (14-37 A.D.) and immediately after the founding of the Empire when the

Republic had been dissolved. He did not write about surgery or medicine alone, but instead encompassed other sciences, philosophy, and law in his many works. He represented Roman erudition at its highest peak, and for Majno, "Celsus is a special case. If this were a play, all the spotlights would be on, Cornelius Celsus would stride out in the glare and hold forth in impeccable, soul-stirring Latin, for his style has few equals in the drab world of medical literature." Celsus was the essence of excellence and one of the main sources—besides Pliny—of information on the management of wounds in Rome. He constituted, in many ways, the savior of the knowledge accumulated regarding Greek medicine, Alexandrian surgery, and Roman medical thought of the times.

Celsus' *De Medicina* was written in the first century of our era, and consisted of eight sections or books. The first four sections described diseases treated by diet and hygiene, and the next four analyzed cases treated by surgery and medicines. In the preface, Celsus introduced a historical survey ranging from the medicine of Hippocrates to the beginning of the Christian era. Overall, his work applied to medicine and surgery and is considered one of the great Latin classics of the times. However, because Celsus was neither a physician nor a surgeon, his writings did not have any influence during his lifetime and practically disappeared from the public or scholarly view.

In 1443, Thomas of Sarzane (later known as Pope Nicholas V) found a copy of *De Medicina* in the papal library of St. Ambrose in Milan. The first printed edition appeared in Florence soon after in 1478. Historians and academicians of that time could confirm the surgical wonders of the past. Majno, in his critical work of the study of man and wounds in the ancient world, describes the significance of encountering this magnificent classic during the Renaissance:

> *"For the discoverers the find was almost too good to be true: Greek medicine in perfect Latin dress! As soon as Gutenberg made it possible, Celsus rode off the press, first among all medical authors, and the only complete medical text that came down from antiquity: the Smith papyrus stops at the waist, the Hippocratic books are a jumble; De Medicina is a gem with all facets intact."*

Only by encountering in full the details of the great writings of Celsus can we determine the specific contributions of those works. Only by exploring Celsus' manuscripts can we understand and

uncover the veil of semi-darkness that existed throughout this period of Roman surgical findings.

Celsus understood and wrote very clearly about surgery. He knew what it meant to be a surgeon. He was aware of the cures obtained by the knife. He recognized the significant impact originating from surgical treatment. Celsus explains:

> *"The third part of the Art of Medicine is that which cures by the hand, as I have already said, and indeed it is common knowledge. It does not omit medicaments and regulated diets, but does most by hand. The effects of this treatment are more obvious than any other kind; inasmuch as in diseases since luck helps much, and the same things are often salutary, often of no use at all, it may be doubted whether recovery has been due to medicine or a sound body or good luck. Besides, in cases where we depend chiefly upon medicaments, although an improvement is clear enough, yet it is often clear that recovery is in vain with them and gained without them: this can be seen for instance in treating the eyes, which after being worried by doctors for a long time sometimes get well without them. But in that part of medicine which cures by hand, it is obvious that all improvement comes chiefly from this, even if it be assisted somewhat in other ways."*

The Celsian surgeon had special characteristics. He was young, of agile mind and strong spirit, had coordinated eyesight, was in control of the circumstances, had similar ability in both hands, was undistressed before the most difficult situations, and was above all, compassionate. He understood this virtue with a unique perspective in mind:

> *"…and compassionate inasmuch as he wishes to heal those whom he treats, but does not allow their cries to hurry him more than the circumstances require, or to cut less than is necessary, and permits the patient's groaning to make not the slightest impression on him in anything he does."*

In his studies, Celsus had learned a great deal from the Alexandrians. As indicated in a previous chapter, the Alexandrian school of surgery represented the essence of anatomy and physiology of the times. For Alexandrians, the anatomical dissection of cadavers was an important element of their study. Celsus absorbed these principles and transmitted them to his generation of Roman physicians.

He penetrated the findings of Herophilus of Chalcedon and Erasistratus of Keos, the two great representatives of the Alexandrians. Celsus clearly understood and transmitted whatever he discovered about these masters of ancient surgery. But Celsus did not stop here. He expanded his writings further to include the status of Roman surgery in his lifetime. He was also fully aware of the Hippocratic influences in the development of the Alexandrian way of thinking regarding the application of rational medicine. Celsus was an excellent writer, observer, compiler, and transmitter of data and in *De Medicina* we can see Celsus' detailed and exhaustive study of the surgery of the times. Even though he was not a surgeon, he wrote with the knowledge and wisdom of the best surgical teachers of the era. Celsus was the master in text, in theory, in exposure of principles, and in the description of new techniques, yet, ironically, he never touched a knife.

It is not known how Celsus learned Hippocratic and Alexandrian theory, how he acquired the writings of their principles, and how he became involved in the Greek canon. There is no evidence that Celsus visited any of the Greek-dominated territories. It is more plausible that Greek surgeons—of Hippocratic or Alexandrian origin—coming to Rome brought with them the real knowledge associated with the surgical practice of the times in Greece and Alexandria. All medical works of any significance up to this point had been written in Greek, and it was not until Celsus that Latin was utilized in his classic text of medicine and surgery, *De Medicina*.

In his study Celsus immediately recognized the significance of the Greek approach to medicine. He realized that the rational method was the most effective in the care of the medical or surgical patient. He made a special effort to absorb all new developments brought in by the distinguished newcomers. Greek scientific medicine encompassed every aspect of improved care. The great centers of ancient surgery, initially located in areas of Greece and other Mediterranean cities, shifted to the Roman peninsula. It was the Roman's turn to preserve and in some ways enhance the surgical tradition. It was their turn to summarize the great advances that surgeons had accumulated up to this time. It was Celsus's turn to excel in his descriptive observations and to present us with all the actions of a vivid and competent knife. The times of the knife were about to show their promise.

In order to fully understand the depth of Celsus' extensive writings, one would have to transcribe his published words as closely as

they were conceived in their original Latin expression. Above all, Celsus was a writer, one of the highest magnitude. He represented perhaps the most sophisticated of the encyclopedists, who organized the existing knowledge in all fields, especially surgery, the area that occupied a great amount of Celsus' attention.

Celsus grasped the meaning of surgery better than any scholar or practicing surgeon of the times. He wrote about multiple aspects of surgical pathology. He described abscesses, infections of all types, fistulaes, ulcers, hernias, hydroceles, benign and malignant tumors, plastic surgery, military surgery, lithotomy, and amputations for gangrene.

In regards to injuries, trauma, and wounds of various types, Celsus presented the following information:

> *"I shall mention the kinds of injury to which the body is liable. These are five; lesions from without, as in wounds; local corruptions internally, as in gangrene; local accretion, as in calculus of the bladder; enlargement of a vein, thus converted into a varix; and local defect, as when a part is maimed…I shall arrange this department of treatment as I did a former one; first treating of those kinds which may befall any part of the body, and those which infest particular parts. I shall commence with wounds.*
>
> *In the wound of the heart there is great hemorrhage; the vessels are collapsed, the complexion pale; there are cold dew-like sweats, of a disagreeable odor; and the extremities becoming cold, death soon follows. When the lung is wounded, the breathing is embarrassed; blood is discharged, frothy by the mouth, florid from the external wound; and with a sonorous puffing of air; the patient like to lie on the wound; some rise up in a state of delirium: many are able to speak if lying on the wound; if on the opposite side, they remain dumb…*
>
> *But should these means fail also, the bleeding vessels should be taken up, and ligatures having been applied above and below the wounded part, the vessels are to be divided in the interspace; that thus they may retract, while their orifices yet remain closed."*

Celsus comprehended extremely well the matter of wound approximation as well as the principles of traction and the type of incision needed for better healing. He described with painstaking detail

the surgical management of mutilations, a complete analysis of what could have been the most important description of plastic surgery of his time. The method of treatment was so precise that we cannot pay justice to his scholarly writing except to present it in a near-complete fashion:

> *"Mutilations then occur in these three parts and can be treated if they are small; if they are large, either they are not susceptible of treatment, or else may be so deformed by it as to be more unsightly than before… The method of treatment is as follows: the mutilation is enclosed in a square; from the inner angles of this incisions are made across, so that the part on one side of the quadrilateral is completely separated from that on the opposite side. Then the two flaps, which we have freed, are brought together. If they cannot be sufficiently brought together, at each end beyond the original incisions semilunar cuts which only divide the skin are made with the horns pointing towards the incisions. This enables the edges to be brought together more easily. No force should be used, but the traction should be such that the edges easily approximate and, when left free, do not recoil much… For instance we should not attempt to make traction upon the lobules of the ears, the bridge of the nose, the margins of the nostrils, or the corners of the lips. But we shall try traction from either side if anything is required for the upper part of the ears, the tip of the nose, the bridge of the nose, the skin between the nostrils, and the middle of the lips. At times the mutilation is in two places, but the method of treatment is the same. Cartilage if it projects into the incision is to be cut away; for it does not agglutinate nor is it safely transfixed by a needle. But it should not be much cut away lest pus collect on each side between the two margins of loose skin. Then the margins after being brought together are to be sutured by taking up from each skin only, and the earlier incisions are also to be sutured. In dry parts such as the nostrils, it is sufficient to spread on litharge. But into the more distant semilunar wounds lint is to be placed in order that flesh may grow and fill the wound; and it is clear that the greatest attention should be paid to what is thus sutured, from what I mentioned above about canker. Consequently every third day the part should be steamed, then dressed as before; and generally the wound has adhered by the seventh day. Then the sutures should be removed, and the wound allowed to heal."*

The depth of Celsus' extensive knowledge also encompassed the treatment of stab wounds to the abdomen. In this area, he concentrated only on injuries of small and large bowels, omitting injuries to the rest of the abdominal cavity, such as trauma of the liver, spleen, pancreas, or any other neighboring organs. One has to wonder about the reasons for not describing those injuries, particularly since these other organs must have been damaged too. It is possible that major injuries of solid organs (e.g., liver, spleen, pancreas, etc.) were fatal and without opportunity for treatment? Is it possible that solid intra-abdominal organs were considered out of the realm of treatment? Is it possible that Celsus plainly dismissed these organs? Unfortunately, we do not have the evidence to answer any number of these questions.

As to Celsus' direct observations pertaining to the care of the damaged small and large bowels, as well as his concerns about the physical appearance of both intestines and the way to handle the return of the loops to the abdomen:

> *"If the small intestine has been penetrated, no good can be done, as I have already said. The larger intestine can be sutured, not with any certain assurance, but because a doubtful hope is preferable to certain despair; for occasionally it heals up. Then if either intestine is livid or pallid or black, in which case there is necessarily no sensation, all medical aid is in vain. But if intestines have still their proper colour, aid should be given with all speed, for they undergo change from moment to moment when exposed to the external air, to which they are unaccustomed…If the intestines have already become too dry, they are to be bathed with water to which a small quantity of oil has been added. Next the assistant should gently separate the margins of the wound by means of his hands, or even by two hooks inserted into the inner membrane: the surgeon always returns first the intestines which have prolapsed the later, in such a way as to preserve the order of the several coils. When all have been returned, the patient is to be shaken gently: so that of their own accord the various coils are brought into their proper places and settle there."*

Celsus appeared to think that a penetrating trauma to the small intestine carried a worse prognosis than injury to the large intestine. This particular point of view changed with time, and modern trauma surgeons know that a penetrating injury to the large bowel carries

increased morbidity and mortality. The Roman author suggested then the necessity for examining any necrotic areas of the bowel and excising them if necessary. He also analyzed various specific ways to suture the remaining bowel.

> *"This done, the omentum too must be examined, and any part that is black (dead) is to be cut away with shears; what is sound is returned gently into place in front of the intestines. Now stitching of the surface skin only or of the inner membrane only is not enough, but both must be stitched. And there must be two rows to stitches, set closer together than in other places, partly because they can be broken here more easily by the abdominal movement, partly because that part of the body is not specially liable to severe inflammations. Therefore two needles are to be threaded and one is to be held in each hand; and the stitches are to be inserted, first through the inner membrane, so that the surgeon's left hand pushes the needle from within outwards through the right margin of the wound, and his right hand through the left margin, beginning from one end to the wound. The result is that it is the blunt end of the needle which is always being pushed away from the intestines. When each margin has been once traversed, the hands interchange needles, so that into the right hand comes the needle which was in the left, and into the left the needle which was in the right; and again, after the same method they are to be passed through the margins; and when for the third and fourth time, the needles have changed hands the wound is to be closed. Afterwards the same threads and the same needles are not transferred to the skin, and stitches are to be inserted by a like method into this as well, always directing the needles from within outwards, and with the same change, between the hands. It is too obvious to need constantly repeating that agglutinants are then to be put out on with the addition either of sponge or greasy wool, squeezed out of vinegar. Over this application the abdomen should be lightly bandaged."*

Celsus was very clear in the treatment of malignant cancerous tumors, adopting a very conservative approach. First, he recommended "to wait and see", since he felt these tumors (malignant) could come back anytime. Second, he recognized that with cauterization (burning) the malignant tumors would be activated and grow faster until the patient died. Third, he never believed in the

curative role of corrosive substances. Finally, he attached little or no effect to the role of surgery in the treatment of malignant tumors. He indicated that if these masses were removed, they would eventually come back, and the patient would ultimately succumb. Today, we know that if oncologic surgeons extirpate cancerous tumors for cure, they are in the early stages of growth and are well circumscribed. Further growth of the lesion would contraindicate its removal, unless for palliative reasons (temporary relief).

Another area of intensified effort in the writings of Celsus concentrated in the excellent description of the operative technique for the extraction of bladder stones. He discussed in detail the characteristics of the patient, the stone's position, and movements, and the surgeon's preparation and maneuvers for the location and extraction of stones. Haeger presents us with an abridged description of the procedure:

> *"On a high chair sits a very strong and intelligent man, who holds the patient, leaning backward and turned away, resting with bottom on his knees. He draws the lower legs backward and lets the patient pull his own knees apart as far as possible. If the patient is relatively large, two strong people sit on two joined stools, and tie together both the stools and their adjacent legs so that these cannot be separated, and then the patient is placed on both their knees in the stated manner.*
>
> *When the doctor has carefully cut his nails and lubricated his left hand, he inserts two of his fingers, first one and then the other, slowly into the patient's rectum, while applying the right hand's fingers to the lower abdomen, also with caution to avoid harming the bladder in case the fingers should meet the stone too strongly from both sides…it is usual that lesions of the bladder cause convulsions which may be fatal. The stone is first sought in the bladder neck and, if found there, it can be brought out with little trouble. If the stone is not there or has receded, the left hand's fingers are pushed up towards the upper part of the bladder, followed by the right hand. The stone cannot avoid being found with the hands, and is then brought down, with ever more caution as it is smaller and smoother, so that it does not slip away. Once the stone has descended, a crescent-shaped incision should be made in the skin near the anus, going into the bladder neck, with its*

corners slightly oriented toward the posterior pelvic bone. Then a transverse cut is made to open the bladder neck. This will expose the stone. If it is small, it can be pulled out with the bare fingers by working it sideways. But if it is bigger, a specially constructed hook must be got around it. This has a thin end with a crescent-shaped, bent plate having blunt teeth, and is smooth on its outside. When the stone is definitely held securely, one makes a threefold movement at almost the same time, to each side and then outwards, but slowly and so that the stone is at first pulled only a little. Then, raising the hook's outer end to make it lie better inside, one can more easily draw out the stone."

The Roman writer did not finish here. Celsus expanded on his advice for the practicing surgeon and gave solutions for complications or other unusual circumstances. He also discussed different techniques for the elimination of bladder stones. On the method of lithotripsy, an instrument was used to crush the stones inside of the bladder, so they could pass readily in small fragments. He gave credit to Ammonius, supposedly a Roman surgeon for the introduction of this particular technique.

Celsus wrote thoroughly on the anatomy and treatment of inguinal hernias as well. He emphasized primarily what general surgeons today know as indirect inguinal hernias. He defined everything he had learned at that time about the anatomy of the inguinal hernia. He gave credit to the Greeks for the discovery of various anatomic structures, and reconfirmed the name of "hernia" for this pathological condition:

"…The testicles hang from the groins, each by a cord which the Greeks call the cremaster with each of which descends a pair of veins and a pair of arteries. And these are ensheathed in a tunic, thin, fibrous, bloodless, white, which is called by the Greeks elytroides. Outside this is a stronger tunic, which at its lowest part is closely adherent to the inner one; the Greeks call it dartos. Further, many fine membranes hold together the veins, and the arteries, and the cords aforesaid, and also in between the two tunics there are some fine and very small membranes, descending from the parts above. Thus far, the coverings and supports belong to each testicle separately; next common to both and to all within is the pouch which is now visible to us; the Greeks call it oscheon, we the scrotum; and at

its lowest part this is slightly connected with the middle coverings, higher up it is only surrounded by them. Now, underneath the scrotal covering many lesions are apt to occur, sometimes after the rupture of the coverings which, as I have said, begin from the groins, sometimes when they are uninjured. Since at times either owing to disease there is first inflammation, then afterwards a rupture from the weight; or after some blow there, there is a direct rupture of the covering which ought to separate the intestines from the parts below; then either omentum, or it may be intestine, rolls down by its own weight; this having found a way gradually from the groins into the parts below as well, there separates by its pressure the coverings which are fibrous and therefore give way. The Greeks called the condition enterocele and epiplocele, with us the ugly but usual name for it is hernia."

On the actual description of the surgical technique, the Roman master writer did not omit any conceivable detail. He even addressed the preparation of the patient prior to surgery, the shaving of the region, and the actual incision to be made:

"But I shall now speak of those cases demanding the knife: for those which are incurable, or should be cared for otherwise, will be mentioned as I come to the separate kinds. Now sometimes the inguinal region has to be cut into, sometimes the scrotum. In either case the man for three days before should drink water (only), and for the day before abstain also from food: on the day itself he must lie on his back; next if the groin has to be cut into, and if the pubes is already covered by hair, this is to be shaved off beforehand: and then after stretching the scrotum so that the skin of the groin is rendered tense, the cut is made below the abdominal cavity, where the membranes below are continuous with the abdominal wall. Now the laying open is to be done boldly, until the outer tunic, that of the scrotum itself, is cut through and the middle tunic reached. When an incision has been made, an opening presents leading deeper. Into this the index finger of the left hand is introduced, in order that by the separation of the intervening little membranes the hernial sac may be freed."

The description of the hernia operation continued, and Celsus outlined all the minute details to complete the surgical technique.

He dealt with the assistant's obligations, which were the management of the testicles, the cutting of the various layers, the repositioning of the viscera, the cutting accessory tissue, and other surgical matters of great concern:

> *"Next the assistant grasping the scrotum with his left hand should stretch it upwards, and draw it away as far as possible from the groins, at first including the testicle itself until the surgeon cuts away with the scalpel all the fine membranes which are above the middle tunic if he is unable to separate it with his finger; then the testicle is let go in order that it may slip downwards, and show in the wound and then be pushed out of the way by the surgeon's finger, and laid along with its two tunics upon the abdominal wall. There whatever is diseased is cut round and away, in the course of which many blood vessels are met with; the smaller ones can be summarily divided; but larger ones, to avoid dangerous bleeding, must be first tied with rather long flax thread. If the middle tunic be affected, or the disease has grown beneath it, it will have to be cut away even as high as the actual groin. Lower down, however, not all is to be removed: for at the base of the testicle there is an intimate connection with the inner tunic, where excision is not possible without extreme danger: and so there it is to be left. The same is to be done if the inner tunic is the seat of the disease. But the cutting away cannot be done quite completely at the inguinal end of the wound, but only somewhat lower down, lest the abdominal membrane be injured and set up inflammation. On the other hand too much of its upper part should not be left behind, lest subsequently there forms a pouch which continues to be the seat of the same malady. The testicle having been thus cleared is to be gently returned through the incision along with the veins and arteries and its cord; and it must be seen that blood does not drop down into the scrotum, or a clot remain anywhere. This will be accomplished if the surgeon takes the precaution of tying the blood vessels; the threads with which the ends of these are tied should hang out of the wound; following upon suppuration they will fall off painlessly. Through the margins of the wound itself two pins are then passed, and over this an agglutinating dressing. But it becomes necessary sometimes to cut away a little from one or other of the edges of the skin-incisions in order to make a broader*

and thicker scar. When this occurs the lint dressing must not be pressed on but must be applied lightly, and over it such things as repel inflammation, unscoured wool or sponge soaked in vinegar: all the other treatment is the same as when suppuratives have to be applied."

Other operations being performed in the Rome of Celsus included the excision of pterygium, "a little fibrous membrane, springing from the angle of the eye which sometimes even spreads so as to block the pupil," and the "cutting away of struma (scrofula)," which is taken out "in a single piece together with its envelope."

Scholars writing about the history of ancient surgery agreed that Celsus probably was the greatest contributor to the knowledge of surgery after Hippocrates and before Galen. In fact, some believe that "the surgery of Celsus showed a notable advance over that of the time of Hippocrates." Celsus' contributions significantly enriched the surgeon's armamentarium. Celsus was the first to describe the four cardinal signs of inflammation: heat, pain, redness, and swelling. Years later, a fifth sign—loss of function—was added by Galen himself. Celsus dealt effectively with the complications of wound injury, such as erysipelas and gangrene. Ligation of bleeding vessels, division in between ligatures, trephination of head wounds, drainage of the abdominal cavity, early removal of breast tissue for cancer, couching for cataracts, and tonsillectomy were other methods used by the Romans during the time of Celsus' classical surgical descriptions.

Following Celsus' extraordinary contributions to the knowledge and understanding of surgery, none of his contemporaries were able to match his erudite and resourceful personality. He wrote extensively and compiled a greater number of classical surgical concepts and techniques. Few surgeons in the past, none in his present time, and only Galen in the foreseeable future could compare to Celsus' writings on the use of the knife. His aptitude as an accomplished writer permitted him to leave a long-lasting surgical gift to humanity, one that would not be easily surpassed by future generations of practicing surgeons.

Of the large number of actual surgeons who practiced in ancient Rome, only four who lived during the time of Celsus and Galen could be considered to have made some advances in the surgical field. Soranus, Rufus, Heliodorus, and Aretaeus were those surgeons who attempted to fill the gap left by Celsus during the first century of our times.

Soranus of Ephesus (98-138 A.D.) was a well-known physician of antiquity. He excelled in surgical matters and was the leading surgeon in areas of gynecology and obstetrics. He began his life in Greece, then traveled to Asia Minor and studied in Alexandria. Rome was the next stop, and he practiced there under the Roman emperor Hadrian (76-138 A.D.). Like Celsus, he reached high marks as a writer of surgical developments. He wrote in Greek, so his works had to be translated into Latin and were thereafter incorporated into the works of other writers.

Soranus made significant contributions to the practice of gynecology and obstetrics, such as the tamponade of the uterus for hemorrhage, the use of a form of hysterectomy for prolapse, the protection of the perineum before delivery by emptying the bladder with a catheter, and the better understanding of the different fetal positions during pregnancy and delivery. He also dealt with and had some recommendations for the management of fractures and skull injuries, as well as the use of bandaging for injury stabilization and wound protection. Atresia of the vagina was identified by Soranus, and he determined its congenital nature or secondary origin. Another area studied by Soranus was pediatrics, to which he made the finest contributions of antiquity, particularly on infant hygiene and nutrition and recognizable diseases, such as rickets.

From the same city of Ephesus where Soranus originated, appeared another reputable surgeon, Rufus (around 100 A.D.). He was older than Soranus and practiced during the reign of Emperor Trajan (52-117 A.D.). Rufus was a well-respected surgeon who described all the known methods of hemostasis, including digital compression, cauterization, torsion, and ligature. He gave the first analysis of traumatic erysipelas, epithelioma, and bubonic plague. He noted that pulse, heartbeat, and systole were synchronous. Rufus made significant contributions to anatomy also, such as descriptions of the crystalline lens, the membranes of the eye, the optic chiasm, and the oviduct of the sheep. He wrote, in addition, a treatise on gout that was translated into Latin centuries later. Rufus added new compounds to the *materia medica*, of which a purgative became well known.

Heliodorus (around 100 A.D.) represented another distinguished surgeon of ancient Roman times. He was a recognized technician and a surgical author of repute. He gave one of the first accounts of ligation and torsion of blood vessels (before other surgeons in Rome) and was the leading surgeon to treat urethral stricture by internal urethrotomy. He reported on head injuries, described the operative

treatment of hernia that included excision of the sac, and presented his method of circular and flap amputations. Next, he describes one of his techniques performing amputations:

> *"Amputations above the elbow or knee are very dangerous owing to the size of the vessels divided. Some operators in their foolish haste cut through all the soft parts at one stroke, but it seems to me better to first divide the flesh on the side away from the vessels, and then to saw the bone, so as to be ready at once to check the bleeding when the large vessels are cut. And before operating I am to tie a ligature as tightly as possible about the point of amputation…A circular incision is made round the digit near its base. From this two vertical incisions are made opposite one another and the flaps so formed dissected up. The base being thus laid bare the digit is to be removed by cutting forceps and the flaps are then brought together and sutured."*

Aretaeus the Cappadocian (81-138 A.D.) was the fourth surgeon of distinction considered during the times between Celsus and Galen. He was a Greek, born in Cappadocia, a Roman province in Asia Minor. He developed a good relationship with Dioscorides originator, of *materia medica*, who was a Greek army surgeon in the service of Nero (54-68 A.D.). Aretaeus was also close to Andormacus, his protector and the personal physician of Nero-Aretaeus. Areteaus studied in Alexandria, where he practiced a great deal of his surgical techniques. He wrote extensively, but few of his original works remain. We know, however, that he was a sound clinician who embraced Hippocratic medicine as closely as anyone in the Greco-Roman world. He rejected speculation and superstition and supported strongly the practice of rational medicine. He belonged to the Eclectic school of medical thought, which included the best of Empiricism and Methodism. Aretaeus' descriptions of pneumonia, pleurisy with emphyema, diabetes, tetanus, diphteria, and epilepsy are now classic.

In closing, venesection on the dorsum of the hand, and trephination of the skull for intractable epilepsy were two of his well-known surgical procedures. Other routine methods on the management of surgical wounds and/or various other techniques were not preserved with his medical and surgical writings.

Next, the Greco-Roman knife will expand its magnificent presence with the master surgeon of all times, Galen of Pergamon.

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CHAPTER 9

Galen's Roman Times
High Expectations of the Knife

> *"There is no better summation of Galen's contribution to the history of medicine than the one given to me in the offhand remark made by a colleague…"Galen," he said, "really started the whole thing, didn't he?" Galen introduced physicians to the anatomical concept of disease, the intellectual system guided by the doctrine that a detailed knowledge of the body's structure is the foundation upon which understanding of disease must be based. Until very recently all progress made in medical science has been the result of increasingly clear comprehension of man's structure and the manner in which each part functions in health and disease."*
>
> —S.B. Nuland
> *Doctors: The Biography of Medicine* 1988:36.

The knife continued its swift sail through Roman times, reaching its zenith with the extraordinary genius of Galen of Pergamon (today Bergama, Turkey) in the second century A.D. Galen (129-200 A.D.) was educated in classical thinking from both the greatest philosophers and the best medical minds of the time. After studying philosophy in his natal city, he moved to Smyrna (Izmir, Turkey) and Corinth, the new capital of Greece, where he learned and practiced medicine for several years. In the famous medical school of Alexandria, Egypt, Galen continued his studies in anatomy. He returned to Pergamon where he was named the surgeon of the gladiators. He was required to improve surgical care to these embattled men. Because of the nature of the gladiators, who were warriors who fought bloody battles to entertain the Romans at the amphitheater, the surgeon in charge, in this case Galen, had to confront bleeding wounds, massively damaged organs, and anatomical disfigurement rather frequently. He had to care for these severely wounded men. Gladiators

Origins of the Knife: Early Encounters with the History of Surgery,
edited by Luis Horacio Toledo-Pereyra.

used a stabbing sword about two feet long, a short curved sword, or a three-pronged spear which were bound to cause great bodily damage during the contest. They were prisoners of war, slaves, or criminals condemned to fight each other or the lions. The fight continued until one was killed although the crowd could save the loser's life if they waved their unknowingly powerful handkerchiefs. Spartacus, one of the most noted gladiators, successfully saved his life on numerous occasions, and his prowess was recounted by the literary magic of Howard Fast and thereafter taken to the big screen by Universal Pictures in 1960 with Kirk Douglas and Jean Simmons as the main characters. This extraordinary movie presented to us in a graphic form the dangerous lives of the gladiators and the way that these fighters would approach and respond to the major event. It is not difficult to imagine how the surgeon to the gladiators, Galen in this case, would have to be a consummate surgeon to aptly attend to these injured Roman warriors.

Although there are no detailed writings as to the exact work Galen performed for those wounded warriors, one does not have to go too far to appreciate the challenging job he had before him. He attended all wounded warriors, the majority of whom had severe injuries that required the controlling of bleeding, suturing open spaces, cleaning and draining wounds, as well as closing wounds. Some of them needed the care of damaged internal organs in relationship to excision and suturing. Knowledge of anatomy and wound care, as well as courage and perseverance, were equally of great demand in this job. Galen superbly fulfilled this position for years, and he was praised for his uniquely positive results and attention to detail.

As his fame grew, Galen wanted to test his fortune in Rome, the great capital of the Roman Empire. Even though Rome was traditionally hostile to foreigners, Galen made his presence felt by demonstrating his great ability for diagnosis and treatment. Soon Marcus Aurelius, the Roman emperor, requested Galen's services as his private physician. He did a remarkable job, and except for five years in between going to Pergamon, he remained in Rome for the last thirty years of his life.

A great deal of what will be described next appeared in previous papers of mine.[1,2] I will utilize the majority of the text of the *Journal of the History of Medicine and Allied Sciences* paper[2] in order to give full credit to Galen and his incredible contributions.

The historical estimate of Galen as a physician has always been high and his writings exerted a profound influence on physiological

thought for more than 1500 years. However, his surgical work has been neglected and its existence even denied. Thus Charles Singer wrote: 'Galen was no surgeon, but his works include accounts of his surgical predecessors'.[3] Although the latter part of the sentence is true, the statement that Galen was no surgeon is not. He did surgery extensively while he was physician to the gladiators at Pergamon and was proud of his surgical techniques and dressings for wounds.

Of the four medical ways of thinking during the second century, Galen belonged to the Pneumatist School with leanings toward the Dogmatic. The Pneumatists believed in a general world-pneuma which all living beings share, as is manifested by their breathing. The Dogmatists emphasized theoretical principles while accepting anatomical knowledge as necessary; they laid a stress on unseen entities and causes.[4]

With the establishment, about 300 B.C., of a medical teaching center at Alexandria by the Ptolemies, the best medical outlook began to be based in anatomy.[4] Herophilus, pupil of Praxagoras, and Erasistratus, pupil of Metrodorus, were observant anatomists who made outstanding contributions to the anatomy of the nervous and cardiovascular systems and developed sophisticated theories of physiological function. About the beginning of the second century B.C., the Empirical School rejected the medical tradition. The Empiricists were interested in practical things and used common explanations for the causes of all diseases. Around 100 B.C. the Roman Empire extended its influence over the Mediterranean World, but Greek medicine remained dominant in it under Roman political rule. Greek physicians were influential at Rome, especially Asclepiades, who founded the Methodist School and who rejected anatomy, refused to accept geographical and climatic theories in the cause of disease, and followed the ideas of Democritus and Leucippus in the atomic theory. In the second half of the second century, Galen pursued the study of anatomy and practiced surgery (Fig. 9.1). Although his work in anatomy was extensive and is well known,[5] much less has been involved with an active surgical practice from September 158 to August 161 A.D. when he was appointed physician to the gladiators for five consecutive times. Several years later, from 177 to 181 A.D., he may have been carrying on an active practice of surgery. Besides, there remain two other periods in his life, when he was appointed physician to the young Commodus (181-193 A.D.), and for several years after 193, during the reign of Septimus Severus, when Galen may have been engaged in the surgical treatment of the injuries of the gladiators.[6]

Figure 9.1. Detail of Galen dissecting a pig from a collection of Galen's works published in Venice in 1565. (Reproduced from Lyons AS, Petrucelli II RJ. *Medicine: An Illustrated History*. New York: Harry N. Abrams Inc., 1978.)

Galen's Point of View in the Value of Anatomy and Dissection in Surgery

There was no doubt in Galen's mind how useful it was for a surgeon to have an accurate knowledge of anatomy, for he said: "If a man is ignorant of the position of a vital nerve, muscle, artery or important vein, he is more likely to maim his patients or to destroy rather than save life."[4]

He defined the limitations of medical knowledge when he wrote:

> *Certain knowledge, as the number and appearance of muscles of the tongue, would be additional, but not primary or essential. An intelligent man may grasp the matter sufficiently by two or three careful dissections by which is revealed what is useful for medical practice and secondarily for the knowledge of nature.*[4]

He recognized the need to know the anatomy of surgically accessible parts when he indicated: "But how can they treat dislocations, whether simple or compound—how can they even open abscesses,

or excise gangrenes, or remove a missile or splinter properly if they have not learned enough to open a vein correctly."[4] He also asserted the necessity of practice: "I expect beginners to practice all such methods, first because I see their necessity and second because of the time needed to learn them."[6]

He severely criticized the lack of knowledge of anatomy and urged the need to master the subject. "As to the nature of the latter the professed experts in anatomy were mistaken about certain parts, notably as to the palm and sole. Because of such ignorance, a certain surgeon of repute, excising a growth in the wrist, rendered the palm insensitive."[6] He persistently mentioned the need for anatomical knowledge: "What could be more useful to a physician for the treatment of war wounds, for extraction of missiles, for excision of bones, for treatment of dislocations, fractures with ulcerations, than to know accurately all the parts of the arm and legs."[6]

Practice and Knowledge of Surgery during Galen's Time

The type of surgery practiced during the second century was not elective, but was related to injuries suffered during combat or in other circumstances. Several times Galen mentioned the treatment of war wounds, the extraction of weapons, and the treatment of fractures and dislocations[4] as a consequence of injuries. However, his surgical practice was not limited to wounds and injuries. He made use of operations that had not been previously described, such as resection of the sternum. A complete description of this case will reveal Galen's concept of surgery better:

> *"When a heart is exposed, your task is to preserve all of its functions unimpaired as in fact they are…And what is strange in that? The slave of Marylus the mime-writer, whose heart was once exposed, was cured and still lives…*
>
> *Since I have mentioned the slave that I treated, there would be no harm in giving details of his case. It is better to consider them because of the usefulness of his history, even if not strictly relevant to the present work.*
>
> *This slave received a blow on the sternum in the wrestling school. It was neglected and later not carefully looked after. After some four months pus appeared in the injured part. To deal with this, the physician operated and, as he thought,*

quickly got the wound to cicatrize, but inflammation and suppuration set in again. Another incision was made. This could not be brought to heal.

His master now summoned a number of physicians, of whom I was one, and asked us to hold a consultation. All agreed that the trouble was suppuration of the sternum but there was visible movement of the heart on the left of it, so that no one dared remove the affected bone, thinking that it would involve a perforation [syntresis] of the thoracic [cavity].

9

I said that I would excise the bone without making what is technically termed a 'perforation.' As to complete recovery, I made no promise, for it was uncertain whether any of the tissues under the sternum were affected and to what extent.

The region being exposed, no more of the sternum seemed affected than had appeared at first. The limits [of the wound] on either side, under which extend the arteries and veins, were seen to be healthy, and I thus gained more confidence in proceeding. When the bone affected had been excised, particularly at the highest level reached by the pericardium, the heart was seen exposed, for the membrane round it had here mortified. We then had little hope for the slave. Yet before long he recovered completely, which would not have been the case if no one had dared to excise the affected bone, and no one would have had the courage to do so without previous anatomical experience."[4]

It is apparent that Galen is describing a case of infected sternum, probably osteomyelitis because of its acute onset, the relatively high incidence of its occurrence and the persistent amount of pus drainage. However, tuberculosis, syphilis or actinomycosis cannot be eliminated. At the present time, whether it was one or another diagnosis, the surgical treatment which Galen applied would still be the same, with a wide excision of the diseased area.[7] Diagnostic and therapeutic aids permit us to diagnose and treat the causative organism specifically, but the same basic method of surgical cure continues to be used.

In describing the surgery with which he was dealing at the time, Galen mentioned specific types of incisions and their applications: "Muscles are best divided along the fibres. Transverse incisions, that is across the fibres, paralyze them, but are sometimes necessary for

the extension of narrow wounds which go deep."[4] Then he said: "In operating we must sever muscles because of deep abscesses or necrosis or sepsis."[8]

He attempted experimental brain surgery:

> *"Insert a hook into the dura mater and draw it upwards. Then first cut through the piece of it that has been raised, so that it may not make contact with the part of the brain lying beneath it…Should the dissection be thus performed, then after you have laid open the brain and divested it of the dura mater, you can first of all press down upon the brain on each one of its four ventricles, and observe what derangements have afflicted the animal…And when one presses down upon the ventricle which is found in the part of the brain lying at the nape of the neck, then the animal falls into a very heavy and pronounced stupor."*[8]

The circumstance in Galen's life which involved him in an intense surgical practice was his appointment as physician to the gladiators at Pergamon. He wrote that he gained the appointment because of his successful treatment for wounds.[9] He held the office of gladiatorial surgeon for approximately thirty-five months and described many details of his practice at Pergamon:

> *"When I was twenty-eight years old, after I returned from Alexandria to my native land, I had the fortune to develop a successful treatment for wounded nerves and tendons. I demonstrated this not only to physicians and friends, but in neighboring cities, so that they can perform the same experiments. This treatment was known, I know not how, by the Pontifex of our city, and he entrusted me with the care of the gladiators while still a young man."*[10]

Then, he asserted that not one of the gladiators treated by him died, and for this reason he was appointed to the same position five times.

Apparently, what he developed in his treatment for injured tendons was a dressing for recent wounds allowing healing by first intention.[7] With the Hippocratic idea that the body was made up of four qualities—heat, cold, moisture, and dryness—and that they entered into the composition of various tissues and organs in different proportions, Galen decided that different remedies were required to prevent suppuration and induce healing.[11] In the light of this theory,

his principle of dry heat application with no tissue damage or "mortification" after treatment is understandable. For wet gangrene he dressed the wound with *omis lyseas* obtained from wheat flour and wood ashes. He mixed them together, made a plaster and applied it on the wound.[10] This process was called dry heat application. For the portion of the wound which was inflamed, red and painful (cellulites), he used warm olive oil; he squeezed the wound and applied dry wool followed by Euphorobia (an African plant) in a form of liquid wax to the lesion.[10]

Galen did not state the precise manner in which he used red wine in the dressing of wounds, and we are therefore unable to determine just how much credit he is entitled to receive for this crude, but apparently effective means of securing local antisepsis.[12]

His management of tendons after injury may be summarized as follows:[8] (a) Tendon approximation by sutures, especially after transverse division; (b) proper bandaging is enough in longitudinal injuries; (c) when the edges of the ruptured tendon were ragged, he trimmed them; and (d) stitches should include each of the muscle and membrane layers.

Galen's surgical work was considerable: he treated fractures, dislocations, contusions, and incised, penetrating, and tearing wounds of all parts of the body, everything from a dislocation of the knee to a fracture of the skull, from lopping off of the ear to a tearing or gashing of the thorax or abdomen.[6] Hippocrates had written his excellent treatise on fractures from observations mostly in connection with gymnastic sports; Galen's surgical opportunity was greater and he took corresponding advantage of it.[6] His anatomical knowledge of the abdominal wall is displayed as follows:

> *"In the mid-abdomen the wall is made up of skin, fascia, the thin membranous tendons of two muscles called by the Greeks Aponeuroses, the bodies of two muscles which extend from the thorax to the pubic bone, a layer of fascia and the peritoneum. The two membranous tendons cleave so closely together that labor is required to separate them and by many anatomists they are considered as one—four fingers breadth from the mid-line of the abdomen we meet the oblique muscles."*[13]

In considering the several types of abdominal incisions, Galen wrote that paramedian incisions offer a better way of closure. In 1940, Maingot[14] pointed out that the lower paramedian incision is by far the best subumbilical incision and is preferable to the midline

incision which is so prone to be followed by ventral hernia, and possibly by strangulation of the small gut. Later on, Kennedy and Madding[15] mentioned that although the vertical incisions, either paramedian or midline, allow easy access to all quadrants of the abdomen, they are attended by a higher incidence of wound complications. Transverse and subcostal incisions lend themselves to stronger repair and are attended by fewer complications. Galen wrote: "A wound in this situation is less dangerous than in the mid-line, since the thin aponeruoses are lacking. In the mid-line stitching is accomplished with difficulty, and the intestines are more likely to protrude and be hard to replace."[13]

When a severe dilation of the intestinal loops appeared, Galen recommended either conservative methods such as heating of the loops or enlarging of the wound. At the present time, the presence of small bowel dilation, mainly by air is reduced by introducing a long intestinal tube by mouth or rectum; sometimes it is even necessary to open the intestine to release the air or fluid by decompression tube. Muscle relaxation is of adequate help in "making room" for the small intestine. Galen wrote:

> *"Hence, the cure [intestinal protrusion] consists in warming it by a sponge wrung out in hot water or better still in hot astringent wine which heats more water and also strengthens the intestine. If we fail in our endeavor to reduce the inflation it is necessary to enlarge the peritoneal wound. When the intestines protrude through a large wound a perfect assistant is required, one able to gather them in his hands and press them into the abdomen so as to leave the opening free for the wound to be brought together and stitched by the operator."*[13]

Galen thus gave a very precise description of abdominal closure. He even mentioned that closure of the peritoneum was not necessary; a question of controversy at the present time. However, in 1970 Peacock and Van Winkle[16] determined from their data collected in animal experiments that there is no doubt that potentially dangerous fibrous adhesions can be eliminated almost completely if no sutures are placed through the peritoneum. Galen said:

> *"In stitching the needle should be thrust from without inwards through the skin and rectus muscle, and then from within outwards through the muscles and skin, repeating this until the wound is closed. Some operators include the peritoneum in the stitches, but this is not usual. The dressing should be soft*

wool dipped in oil moderately warm and cover the space between the flanks and armpits."[13]

Galen drew a definite distinction between wound treatment of the large intestine and small bowel. However, he said mistakenly that the large intestine heals more easily than the small intestine. It is well known that wounds of the small intestine heal more predictably and with fewer complications than wounds of the large intestine because of better blood supply, a better developed muscular layer, the liquid state of its contents, and a smaller content than other areas of the gastrointestinal tract.[16] Galen wrote: "Wounds of the large intestine heal easily, of the small intestine with difficulty, of the jejunum not at all, on account of the size and number of vessels and because the wall is thin and filamentous."[13]

The instruments used by Galen were knives of various lengths with sharp and blunt points, hammer, chisels, with a flat and with a curved cutting edge, the lower point protected by a lenticular knob to avoid wounding of the dura mater, drills and trephines of various size, and elevators and blunt dissectors for lifting fractured parts of bone without injuring the dura mater.[6] Other instruments, such as scissors, forceps, saws, retractors, hooks, needles, thread for suturing, ligatures, catheters, probes, bougies, syringes, splints, cannulas for empyema and for ascites as well as nasal, rectal, and vaginal specula were in common use in the ancient world.[6] The surgical instruments discovered in the excavations of Pompeii have very similar characteristics to those attributed to Galen.

The opportunities for Galen to perform surgery during the days of the gladiators' games were extensive, frequent, and rarely obtainable even today. His treatment of patients severely injured in battle was good and carefully thought out.[17] In addition to the treatment of injuries, Galen[18] described the removal of goiter by the knife. He also mentioned the existence of "atheromata, steotomata, melicerides"[13] and similar conditions. Their nature becomes apparent from their names, for one finds gruel-like matter in atheromata, tallow-like substance in steotomata, and honey-like substances in the melicerides. Other pathological processes such as wet gangrene, pneumatocele, herpes, cancer, and aneurysms were well described by Galen. In addition, he described cancer of the breast, and advised early operation through healthy tissue, stating that cure could not be attained unless one got out all the roots.[19] Umbilical hernia was treated by passing a double thread through the navel with a needle and tying around it.

It is clear from these descriptions that Galen practiced as much surgery as the surgical methods available in his time permitted. In addition, he utilized his own methods of treatment with outstanding results.

Galen's Concept of a Surgeon

In Galen's mind a surgeon was a qualified physician who should have a well-developed knowledge of anatomy and physiology and an awareness of the value of dissection. He should be meticulous in handling the tissues, in continual practice and should have an experimental attitude of mind in approaching each new problem. This concept of Galen's was not distant from the present concept that a surgeon should be a man of great dexterity and skill in operating, with highly developed diagnostic powers and a thorough training in physiology, pathology, and microbiology, and one who has at the same time the spirit of the laboratory investigator and theoretical teacher.[20] Such a concept includes the surgical academician of today who has a keen interest in research[21] as well as an innovative spirit in the practical aspect of the surgical sciences.

Galen's Stature as a Surgeon

It is readily apparent that Galen had the keen sight, dedication, and experimental method of an anatomist of the first rank. He also was a notable physiologist as well as a vigorous writer and debater. In accordance with his anatomy Galen must have been a better surgeon than is usually supposed.[22] Galen's work in surgery proper has been compared unfavorably with his work in pathology and therapeutics.[19] If his surgical observations scattered through his extensive anatomical works are taken into account, this low estimate of his surgery is not justified.

Surgery: General Principles and Classification

In his writings, Galen discussed surgery frequently, its definition, classification, and applications. We can follow him in each one of his considerations:

> *"Surgery is the methodical removal of what are called foreign tissues by means of incision and approximation, together with the after treatment of wounds and incisions, practiced on the human body. All the operations in surgery fall under two heads, separation and approximation. Approximation has to do with the reduction and dressing of fractures, reduction of dislocation*

of the joints, reduction of prolapsed intestines, uterus, or rectum, suture of the abdomen and restoration of tissue deficiencies, as in the nose, lips and ears. Division is concerned with simple incisions, circumcisions, elevations of skin, scalping, excision of veins, amputation, cauterizations, scraping, smoothing, excisions with the saw."[23]

In considering the treatment of abscesses, Galen used the same method as at the present time. In the extremities, longitudinal incision, evacuation of the mucoid pus, and delayed suture[24] represents the best therapy. Antibiotics were added later to treat the specific infective cause. For abscesses in other locations, the treatment remained the same, but the incisions were made according to the affected area. Galen wrote:

"We employ the simple incision in all abscesses. One should incise longitudinally to the limb, not transversely. Curved incisions, shaped like the myrtle leaf, may be employed in the axilla, groin, buttocks, and seat; elevation of the skin in the forehead when there is a watery discharge from the eyes, and scalping when the skin over the occiput or of the prepuce turns black; amputations when the limbs turn black, and excisions in fractures of the skull."[25]

Galen did not stop at that point in the treatment of abscesses; he stated the need to eliminate the necrotic tissue wherever located. He advised the use of cauterization very extensively; indeed, he found a use for burning in nearly every surgical case. Although the cautery is applied very often in present surgical practice, sutures and well-tied stitches are still preferred in certain critical anatomical areas. But what is important is that the use of the cautery was so well developed at that time. Galen said:

"In all diseases and injuries of the bones, cauterization, scraping, smoothing and sawing may be very useful, and also in those of many other parts. We employ burning with the cautery especially for all diseases which eat into the tissues, and also in watery discharge from the eyes, hips or internal organs. The cautery is employed also in consumptives, patients with enlarged spleens, and habitual dislocation of the shoulder joint, in lachrymal fistula, in the resection of gangrenous tissue, where bleeding takes place on account of the opening of vessels, or in bleeding from other causes."[25]

Orthopedia and Neurosurgery: Skull Fractures

The importance of securing an accurate, detailed history of patients with head injury cannot be overemphasized. Among the several skull fractures is the depressed fracture which is sometimes seen in the infant resulting from a blow to the head or perhaps in the newborn resulting from pressure of the obstetrician's thumbs or a forceps injury. Due to the fear of medicolegal complications, these lesions are usually treated radically in this country by surgical elevation of the fragment. If the fracture consists of large depressed bone fragments, it may be advisable to turn a curved scalp flap with the incision along the margin of the fracture and then incise the pericranium at the periphery of the bone fragments. With the aid of a curette and a rongeur, the bone may then be elevated, leaving the pericranium attached as a matrix upon which the bone fragments may cling.[26] In the treatment of these fractures, Galen said:

> *"In the following kinds of fracture of the skull, surgery is required: fracture, depressed fracture, fracture with hematoma, separation and lifting (or vaulted fracture), and sixth, the so-called trichiasis, which is evidently a superficial gouging of the bone. All kinds of fractures of the skull are treated by chiseling out the fractured parts, cutting clear round the fracture with the chisel. The ancients used to cut them out with circular trephines which they rotated, later head augurs were employed, which gave starting points for the chisels. For the moderns the chisels alluded to above suffice."*[23]

Galen recognized and described a treatment for hydrocephalus. Hydrocephalus is a term describing a variety of conditions in which there is an excess of fluid in the cranial cavity. The term *external hydrocephalus* has been used by some authors to describe the accumulation of fluid and blood in the subdural spaces in infants with subdural hematomas or hygromas. It is customary to divide the cases of congenital hydrocephalus into two groups, communicating and noncommunicating, depending on whether or not there is free communication between the fluid in the ventricles and in the lumbar subarachnoid space. Numerous operations have been devised for the relief of congenital hydrocephalus, the most satisfactory of which are excision or coagulation of the choroid plexus, puncture of the third ventricle and various shunting procedures.[27] Galen wrote:

"There are four kinds of hydrocephalus, one between the brain and the meninges, one between the membranes and the bone, one between the bone and the pericranium, and one between the bone and the skin. In the skin occur favus, wens, and on the outside, baldness. For favus or wens we make either a straight or curved incision on the surface, and pull out the sac with the fingers and remove them with the fluid contained in them. Hydrocephalus under the skin and pericranium we empty by two or three incisions. Those beneath the bone we chisel out. These between the meninges and the brain do not admit treatment."[23]

General Surgery and Tumors

Galen's description of general surgery and tumors is clear and does not need introduction. He treated any kind of 'growths' by removal, he removed tonsils which had been hypertrophied, he excised fatty tumor, he did not treat ozenas, that is, fetid polyps in the chronic form of rhinitis.[28] The ganglia or subcutaneous tumors were mashed and the abscess incised and drained. He even mentioned the treatment for carcinoma of the breast by removal. Although Galen described three kinds of exomphalos and he mentioned its surgical approach, he did not go into details. Presently, it is usual to distinguish two types of exomphalos. In the so-called hernia into the cord, there is a narrow neck at the point where the protrusion passes through the skin, but the more distal part may be large and may contain much of the small intestine. In the second type the sac appears to be hemispherical with a wide neck. The difficulty of management depends more on the width of the neck than on the total size of the protrusion. When the neck is wide in proportion to the total size, but the protrusion is not large, it is usually possible to mobilize the skin sufficiently to close it over the defect and it may be possible to obtain an independent closure of the rectus sheath as well.[29] The sac should be retained intact to prevent the intestines from adhering to the mobilized skin and fat. Galen described:

"As for cancerous growths in the nose, polyps, we remove them with a narrow knife, and afterward scrape off their roots with a curette. Ozenas ordinarily are not cured by treatment. The same treatment is applied to them. Gum boils on the top and sides of the gums we incise, when they have been brought to suppuration. Relaxed uvulae we seize with forceps and cut

clean off. We pull out teeth after cutting the gum around them. Tonsils which are enlarged beyond their natural size we remove by scissors. In fatty tumors and swollen glands in the neck we make a superficial incision; and skin them out with the fingers, separate the net of blood vessels, and take them out. Ganglia usually occur over the metacarpus and in workers on wool, in general we mash them, and then apply cerate till they subside.

Abscesses and suppurating glands in the axilla we incise and remove, likewise those in the groins. Abscesses in the intercostal space we incise, but allow the pus to escape only gradually, not all at once. Some open them with the cautery. Carcinomata occur in many parts of the body especially about the breast. Wherever they are we excise them, and cauterize them with a cautery which is not too hot. Some employ hot knives, which cut and burn at the same time. All patients whose navel protrudes are called exomphali. There are three kinds. Some have a wind in the navel, some intestine and some water. All three kinds come to surgery. A double thread is passed through the navel with a needle and tied around it. For fluid in the abdomen we puncture with a myrtle-shaped iron trocar into the cavity."[23]

Genito-Urinary Surgery

At the beginning of his urological descriptions, Galen defined the surgical approach of phimosis and hypospadias. It is well known that phimosis, a disease in which the patient cannot retract the foreskin over the glans, should be treated by circumcision when the inflammatory reaction has subsided.[30] Hypospadias represents ventral curvature distal to the urethral meatus. The meatus opens on the ventral side of the penis proximal to the tip of the glans penis. Adequate surgical correction demands, above all, straightening of the shaft and formation of a urethra which extends to or near the tip of the glans.[30] Galen said:

"There are two cures for shortening of the prepuce, one by undermining the skin on the inside, another by incising superficially around the outside in a circle, so that the penis may be drawn in. For phimosis one operates on the prepuce by drawing it up as far as possible, then releasing the scar with a phlebotome. Hypospadias is a congenital condition where the

urethra opens beneath, under the so-called frenum. It is cured by boring a hole through the top of the glans and inserting a small tube. In the so-called 'impervious' cases, whether they have a very small opening or none at all, we operate as follows: We open them with the sharp point of the lancet and then push in the finger and free them all around."[23]

Galen goes on with his urological practice. He described the extraction of stones from the bladder. His technique did not differ a great deal from the methods used by William Cheselden in the eighteenth century. Cheselden modified the lateral lithotomy method of Frene Jacques in the following manner: he divided the membranous and prostatic urethra by cutting on to the lateral groove of the catheter which was held steadily by an assistant so that it was kept near the pubis; meanwhile the surgeon kept the rectum back out of the way with the fingers of his left hand.[31] In the final form of the operation, the incision into the urethra began at the vesical end and finished near the bulb. At the present time, although vesical stones are rare in this country, their treatment may be summarized as follows:[31] small stones can be removed by cystoscopic manipulation, large ones may be crushed and the fragments washed out. When stones are too large for transurethral removal or crushing, they may be removed by operation through the suprapubic route. If the patient has an obstructing prostate, suprapubic prostatectomy is indicated at the same time. If the patient is considered to be an unwarranted surgical risk or if he refuses cystoscopic removal, chemical dissolution may be indicated. Galen wrote:

"Patients who have a stone in the bladder we cut, after wedging the stone into the neck of the bladder and using the stone to cut down upon. We go through the overlying tissues with our incision and take out the stone with the stone forceps. Those with dribbling of whatever origin, if the scar is large, we cut it out and destroy it. When retention of the urine is excessive and troublesome, so that the bladder is distended and cannot contract, we draw off the urine with a catheter. The catheter is shaped like the Roman letter 's'. It is pushed into the penis through the urethra as far as the bladder. It has a little wool attached to the end at the tip by a thread through the catheter, extending out a little, which is wet with the urine first, and then drawn out. Then the urine follows, following its lead, so to speak."[23]

In Galen's description of scrotal tumors, he distinguished seven kinds. Although they are located in the scrotum, their anatomic content belongs to the spermatic cord. Apparently, Galen did not realize their relationship to the spermatic cord, but his descriptions are accurate and his treatment appropriate. Among disorders of the spermatic cord, spermatocele does not require therapy unless it is large enough to annoy the patient, in which case it should be excised. Varicocele, common in young men, consists of dilation of the pampiniform plexus about the testis; no treatment is indicated unless it is painful or is thought to contribute to infertility, in such a case, ligation of the internal spermatic vein and the internal inguinal ring is required.[31] Hydrocele, collection of fluid within the tunica vaginalis, should be treated when symptoms are present; resection of the parietal tunica vaginalis would be indicated.[31] Some other conditions, such as enteroceles and epiploceles, although they express themselves in the scrotum, are actually hernias of intestines or omentum into the scrotum through the inguinal ring. Galen described and offered treatment for these entities. He wrote:

> *"In the scrotum there are seven kinds of tumors; hydrocele, porocele, fatty tumor, sarcocele, omental hernia, varicoceles, hernia of the bowels. To these some add hydro-enterocele and sarco-epiplocele. In hydrocele one should cut through the scrotum, where it has the least veins, and when one gets to the sac containing the fluid, empty it, and remove the redundant part of the sac; in those that have no sac it is sufficient to remove the fluid. Fatty and callous tumors must be excised by stretching the scrotum uniformly over them with the left hand, then cutting from the surface down till we come to the fat or callus, or whatever else it is, and removing it. Sarcoceles are treated in the same manner. One should carry the incision around and remove only the subjacent white tissue, skinning off the red, and pushing it aside, then remove the separated (white) tissue. In varicoceles, make a superficial cut, lift up the varix with a hook, leave behind a section about as wide as the little finger, lift up and cut off the rest. One must take pains to spare the testicles, which are closely involved. We incise enterocoels and epiploceles in this way, carefully pushing the bowel and omentum up out of the way, then close the inguinal ring as well as we can. If this cannot be done, we draw up the peritoneum, tie it off and remove it."*[25]

Proctologic Surgery

Galen referred to the surgical treatment of hemorrhoids and the treatment of what may have been fistula-in-ano. At the present time, operation for internal (or external) hemorrhoids consists of excision of the redundant mucosa and venous network and meticulous suture of the operative site to control hemorrhage and to produce adhesions to the underlying muscle during healing.[32]

A juxtarectal abscess nearly always precedes the formation of fistula-in-ano. Excision rather than merely laying the tract open is appropriate inasmuch as it allows the defect to heal by granulation from the depths of the wound. Special attention should be directed to the preservation of the internal sphincter. The recommended procedure when the internal sphincter is affected is to open the tract widely, preserving the sphincter, about which a loop of heavy suture material is loosely tied; at a second stage, four to six weeks later, the fibrosis induced by the presence of this seton will permit complete opening of the tract with division of the internal sphincter without loss of continence.[32] Galen mentioned:

> *"In hemorrhoids we pass a thin double linen thread through the base, tie them off, and cut them off after two hours. Of fistulae some are not penetrating, and so have only one opening. Penetrating fistulae have an opening either into the rectum or on the outside. Those which perforate into the rectum we treat by pushing a probe through them, then introduce a finger into the rectum, stretch the rectal wall over the tip of the probe, and excise it from below upwards. The procedure is suited likewise to those that open on the outside. In a perforated case one should divide all the healthy tissues with the sharp edge of the probe-pointed knife. Some, instead of incising or excising the tissues between the openings, tie a linen thread to the end of the probe, tie it tightly around the overlying tissues which have to be divided, and tighten the knots each succeeding day, till it cuts through the tissues, and then induce healing with the Egyptian remedy. This method of treatment was first described by Hippocrates."*[23]

Vascular Surgery

The present treatment for varicose veins of vein ligation and stripping is well described by Galen in his writings:

> *"In varicose veins of the legs we mark out the whole extent of them by scratches on the outside, then put them on their backs, take hold of the skin surface, and divide that first, then lift up the varicosity with a hook and tie it off, and do the same thing at all the incisions. Or we pull them out with a varicocele hook and cut off the ends, or we pass a thread through the coil of veins with a probe and pull them up and take them out."*[23]

Chest Surgery

There is one more of Galen's surgical procedures which should be mentioned: rib resection or chest drainage for empyema. In this procedure he followed the Hippocratic approach:

> *"First incise the skin between the ribs with a broad knife, then wind the blade of the knife with a strip of linen leaving out the point to the breadth of a thumb nail, and push it in. Then when you have let out as much pus as you think best, stuff the wound with a drain of raw flax to which a thread is attached. Let out the pus once a day."*[33]

These descriptions suggest the industrious surgical work of Galen. They demonstrate his real contributions to surgery. His surgical experience is obvious, his surgical statements are clear and his historical position as an important surgeon of antiquity should be reconsidered and highly praised.

Led by the genius and extraordinary surgical skills of Galen, the expression of the knife was at its prime, as displayed by the positive response of most of his patients. Removal of nasal polyps and varicose veins, extirpation of cancerous tumors, suturing of the bowel and abdominal wounds and trephinated skulls were all part of Galen's surgical repertoire. He became the most remarkable and, at the same time, controversial surgeon of the era. He was a bold and determined operator with innovative ideas. Galen dissected hundreds of animals and a few humans despite the powerful religious leaders and strong social mores of his time. This futuristic yet stubborn attitude brought him pain and aggravation from the authorities. However, despite his often troubled career, the influence of Galen's writings clearly and consistently persisted until the Renaissance.

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CHAPTER 10

Close of an Era

As we reach the end of the *Origins of the Knife*, we recognize empty spaces still present in the growth and maturation of this yet crude instrument. It took centuries of valor, determination and commitment to explore the confines of this incredible story. Surgery had not been completely identified as a credible profession up to this point. Only a considerable number of years of dedication and study was going to convince the public of the value of the emerging surgeon.

We searched from north to south, from east to west, to recognize the early works of those masters of the knife. Courage over knowledge, craft over science, encouragement over pessimism were the hallmarks of the early pioneers. From the primitive surgeon to Imhotep, from Hippocrates to Galen, from Sushrupta to the Yellow Emperor surgeon, we encountered faith, willingness and desire in their daily practices.

Although the initial seeds in the understanding and use of the knife were planted by the first surgeon of earth, only long periods of nurturing would allow patients and doctors the best fruits ever possible. After centuries of practice, the professionals of the knife had learned how to use it even though up to the second century A.D., where this book ends, knowledge was uniformly scarce until the coming of future generations who were about to bring new technical advances as well as new means to understand the practice of surgery.

We hope the reader had the opportunity to penetrate the intricate roads of the initial developments of the knife. We hope we offered the fundamental tools for further inquiry into the earliest history of surgery. We hope the events of these times are a monument to the unsung heroes of our story. We ask for benevolence in the assessment of this work for which the only goal was to bring to the general and interested public the positive message of our surgical forefathers.

Origins of the Knife: Early Encounters with the History of Surgery,
edited by Luis Horacio Toledo-Pereyra.

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