

Neurosurgery in Ancient India: Susruta

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Abstract

Neurosurgical procedures, particularly trepanation, can be traced as far back as 10,000 BC. Archeological findings from Africa, Asia, Europe, and South America provide evidence that trepanation was widely used by man for mystical purposes, surgical treatment, and reasons still unknown to us. Hippocrates (460–370 BC), in his book *On Injuries of the Head*, has long been thought to be the first to provide instructions, indications, and warnings on the subject of trepanation and neurosurgical pathologies. Building on the writings of Hippocrates, Galen (129–200 AD) has been credited for his contributions to neurosurgery through his additions in neuroanatomy. The purpose of this article is to present the work of Susruta, an Indian surgeon who lived around 800 BC, and his treatise on surgery, the *Susruta Samhita*. Closer examination of the work by Susruta reveals his vast knowledge of physiology, pharmacology, anatomy, and all topics related to medicine. We will focus on descriptions of Susruta of neurosurgical anatomy, pathology, and procedures, hoping to provide enough evidence that neurosurgery was documented and taught years before significant advances were made in the West.

Keywords

- ▶ Susruta
- ▶ *Susruta Samhita*
- ▶ Ancient India
- ▶ ayurvedic

Introduction

Trepanation, a neurosurgical procedure in which a hole is drilled through the skull up to the dura mater, is one of the world's earliest practiced surgical procedures. Evidence of its use can be traced back as far in time as 10,000 BC, and as widespread as Mesoamerica, South America, Africa, Asia, and Europe.^{1–3} The use of trepanation in India has been traced as early as 2,350 to 2,050 BC (4,300–4,000 BP), to a skull from the Neolithic pit dwellers of Burzahom in the Kashmir Valley region in-between present day India and Pakistan (▶ **Fig. 1**, Sankhyan and Weber).⁴ The Edwin Smith Papyrus, the world's earliest known medical document dated around the 17th century BC from Ancient Egypt, contained the first written descriptions of neurosurgical anatomy in soldiers injured during battle. The Papyrus is thought to have contributions from multiple authors and contains rational treatments for head and spine cases, but it does not offer any specifics about the management of head injuries using trepanation.¹ Although historically, the first

written descriptions about the use and warnings regarding trepanation in the management for head injuries has been attributed to Hippocrates, the great Greek physician scientist during the fifth century BC,⁵ Susruta appears to have described cranial surgical procedures dealing with warfare injuries and trepanation a few 100 years earlier.⁶

Because of the oral tradition of the Indo-Aryans, the majority of information passed down from generation to generation was most likely never written. This includes most ancient texts including the *Vedas*, whose information is undoubtedly much older than the date attributed to their transcriptions.⁷ During the Vedic period of Hindu medicine (1,500–800 BC), all knowledge, including medicine, was passed down through poetic hymns consisting of songs and prayers.⁸ Included among the four *Vedas*, the oldest scriptures of Hinduism, were hymns about medicine and surgery.⁹ Interspersed among these hymns were medical treatments consisting of amulets, magic, offerings, penances, and other early forms of witchcraft and incantations.¹⁰ Not until ~800 BC, did Susruta begin to rid Indian medicine of its

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Fig. 1 Sketch of the trepanned skull from approximately 2,350–2,050 BC (4,300–4,000 BP) found in Burzahom, which is located approximately 10 km north-east of Srinagar in the Kashmir Valley. This site was excavated between 1961 and 1968. The skull, belonging to a female aged between 26 and 30 years, shows a total of 11 attempts at trepanation. Reprinted with permission from John Wiley and Sons (Sankhyan and Weber⁴).

magical practices and lead it toward a more organized and studied approach.¹⁰

Who Was Susruta? Background and Education

Susruta, claimed by several authors and historians “as the father of surgery,”^{11–13} lived approximately around 800 to 600 BC.^{14–16} As described by Keswani, the time period

beginning around 1,000 BC, was a time where significant advances were made in mathematics and exact sciences, including astronomy and physics.¹⁵

Susruta, the son of the well-respected sage Vishwamitra,¹⁷ is believed to have been born near Bihar, which is located in the Eastern part of India.¹⁸ Although numerous accounts of how Susruta amassed his vast medical knowledge exist, most accounts point toward Dhanwantari, “the physician to the gods.”^{6,19,20} Although there has been some confusion about whether it was Dhanwantari or Divodasa who gave Susruta the Ayurveda,⁶ a system of traditional or alternative medicine native to India, it is clear that Susruta was the recipient of this knowledge. Susruta, along with other disciples requested that Dhanwantari teach them the science of healing to help those afflicted with illnesses. Dhanwantari agreed to provide the information they requested and began his instruction of the Ayurveda with the topic of surgery. He stated,

“Of all branches of medicine, the science and practice of surgery is most useful, for, with its help one could gain the results very soon. By its practice, we may acquire fame, piety, and may secure Heaven after death.”¹⁷

Susruta’s Contributions to Medicine

Plastic surgeons claim Susruta to be the “father of plastic surgery” for his methods of nasal reconstruction and skin flap surgery (→**Fig. 2**, Loukas et al¹⁸) (→**Fig. 3**, *The Gentleman’s Magazine 1794*).¹² Urologists regard some of his principles and hypotheses for urological procedures, including vesicolithomy, as advanced for his time.²¹ In addition to his contributions to neurosurgery,⁶ many scholars credit him with discoveries in the fields of



Fig. 2 Susruta is performing an otoplastic operation where the patient was drugged with wine and steadied by friends and relatives. Susruta is using a section of flesh cut from the patient’s cheek. It will be attached to the stump of the mutilated organ, treated with homeostatic powders, and bandaged. Reprinted with permission from John Wiley and Sons (Loukas et al¹⁸).



Fig. 3 This engraving depicting a rhinoplasty appeared in *The Gentleman's Magazine* in October, 1794. The rhinoplasty was supposedly performed following Susruta's surgical technique which was developed over 2,000 years before this publication (*Gentleman's Magazine* 1794).

ophthalmology,²⁰ dental surgery,²² and cardiology,^{13,22} among other fields.

Susruta is accredited for the systemization of early Indian medicine in his treatise, the *Susruta Samhita*. He taught and practiced medicine in Banaras, an ancient city on the banks of the Ganges river.²³ In a structured program, he encouraged future surgeons and physicians to take hands on approaches to medicine and surgery through the study of anatomy. This was challenging during that time period, as the mutilation of dead bodies was prohibited.^{6,10} To train surgeons without cadavers, he advised his pupils to practice on the carcasses of animals, fruits and vegetables, lotus stalks, and leather bottles among other items to acquire the skills required for particular procedures.²⁴ Susruta eventually discovered a method in which he could study cadavers layer by layer to understand the complex anatomy present in the human body.²⁰ This process, termed *Avagharshana*, is described in the translation of the *Susruta Samhita* by Bhisagratna:

Cover a dead body with *Kusa* grass and place it at the edge of the water of a rivulet. After three days take it out carefully, and gradually take off the successive layers of the epidermis and dermis of the muscles beneath by gently and lightly rubbing it over with a soft brush. Thus the smallest and thinnest arteries, which have by this time swelled and obtained a distinct existence are made palpable everywhere even to the minutest.¹⁷

After completing the training program, each student took an oath, similar to that of Hippocrates, a few hundred years later, before they began treating patients:

Thou shalt renounce lust, anger, greed, ignorance, vanity, egotistic feelings, envy, harshness...falsehood, idleness, nay all acts that soil the good name of a man...live the life of a truthful, self-controlled anchorite and be obedient and respectful towards thy preceptor...Thou shalt help with thy professional skill and knowledge... the helpless and those who shall come to thee from a distance...and thou shalt give them medicine [without charging for it any remuneration whatever]...¹⁷

Through his skills as an educator, Susruta was able to propagate the teachings of Ayurveda imparted to him (→**Fig. 4**; Loukas et al¹⁸).

Susruta's Treatise: The Samhita

Two early Indian texts, the *Susruta Samhita* and the *Charaka Samhita* form the foundation of Ayurveda, the Indian system of traditional medicine. The Samhitas, Sanskrit for "collection of mantras" or "collection of knowledge," refer to eight branches of Ayurveda. Charaka, who was a contemporary of Susruta, created the *Charaka Samhita* which focuses more on medicine. The *Susruta Samhita*, although a complete work on medicine during that time, gave a special attention to surgical treatments. It is divided into two parts, the *Purva-tantra* and the *Uttara-tantra*, which encompass specialties such as medicine, pediatrics, geriatrics, otolaryngology, toxicology, and psychiatry. In 184 chapters, it describes in detail approximately 1,120 specific diseases and over 300 types of operations that require 42 different surgical procedures.^{6,25} The level of detail is so comprehensive that Susruta delves in 76 different eye diseases requiring 51 surgical treatments, along with a procedure for removal of cataracts. His other contributions include instruction on performing laparotomies for the delivery of babies, removing of gallstones/urinary calculi, and even repairing intestinal transections with the heads and mandibles of large black ants.¹⁰

The book categorizes surgical methods into the following seven divisions: *Chedya* (excision), *Lekhya* (scarification), *Vedhya* (puncturing), *Esya* (probing/exploration), *Ahrya* (extraction), *Vsraya* (evacuation), and *Sivya* (suturing).²⁶ For each surgical method and situation, Susruta provides the particular tool that must be used.

Susruta's Instruments

There are numerous references in historical texts and articles to surgical instruments used in ancient surgical procedures. Historians describe the Sumerians who used small copper knives (3,000 BC) and Egyptians who used bronze medical tools including scalpels dating more than 4,200 years ago.¹¹ Unlike the surgeons before him, Susruta was the first to describe in detail the surgical instruments he used. He led his contemporaries not only in the practice of surgical procedures and treatments, but also in the development of surgical instruments. He described and used a variety of instruments for all types of surgical procedures, including neurosurgical procedures involving the cranium and spine.⁶ He



Fig. 4 A painting depicting Susruta examining and performing a procedure on a patient. Susruta had great knowledge regarding head and neck anatomy, and used it to perform procedures accessing the skull and removing cataracts, among others (Loukas et al¹⁸).

even described instruments such as endoscopes and rectal speculums.¹¹

In total, Susruta used and gave a detailed description of 121 instruments, 101 blunt instruments and 20 sharp instruments. He classifies the instruments into six categories by their shapes (cruciform, pincerlike, spoon-shaped, tubular, rodlike, and accessory instruments). The instruments were constructed after the shapes of animals in nature, including birds and wild animals such as lions. In addition, he designed sutures from flax, hemp, bark fiber, and horse or human hair.⁸ Susruta writes extensively about how these instruments should be created, what procedures they would be used in, and the manner in which they should be maintained. When discussing the forceps (*Svastika*), he

divides them into 24 classes, each varying in size and shape as they resembled the mouths of birds and other various animals.¹⁷ He paid particular attention to the sharpness, length, and overall quality of each surgical instrument, carefully describing the 12 defects which he believed would cause an instrument to be flawed.¹⁷

The blunt instruments were used for the removal of foreign bodies, suction of fluids, and retracting or moving structures obstructing the surgeon's view. The sharp instruments included a circular knife, bone saw, lancet, suturing needle, chisel, and scalpel along with others (►Fig. 5, Bhisagratna).¹¹ These instruments both sharp and blunt, were used for a variety of procedures, including but not limited to the neurosurgical types.

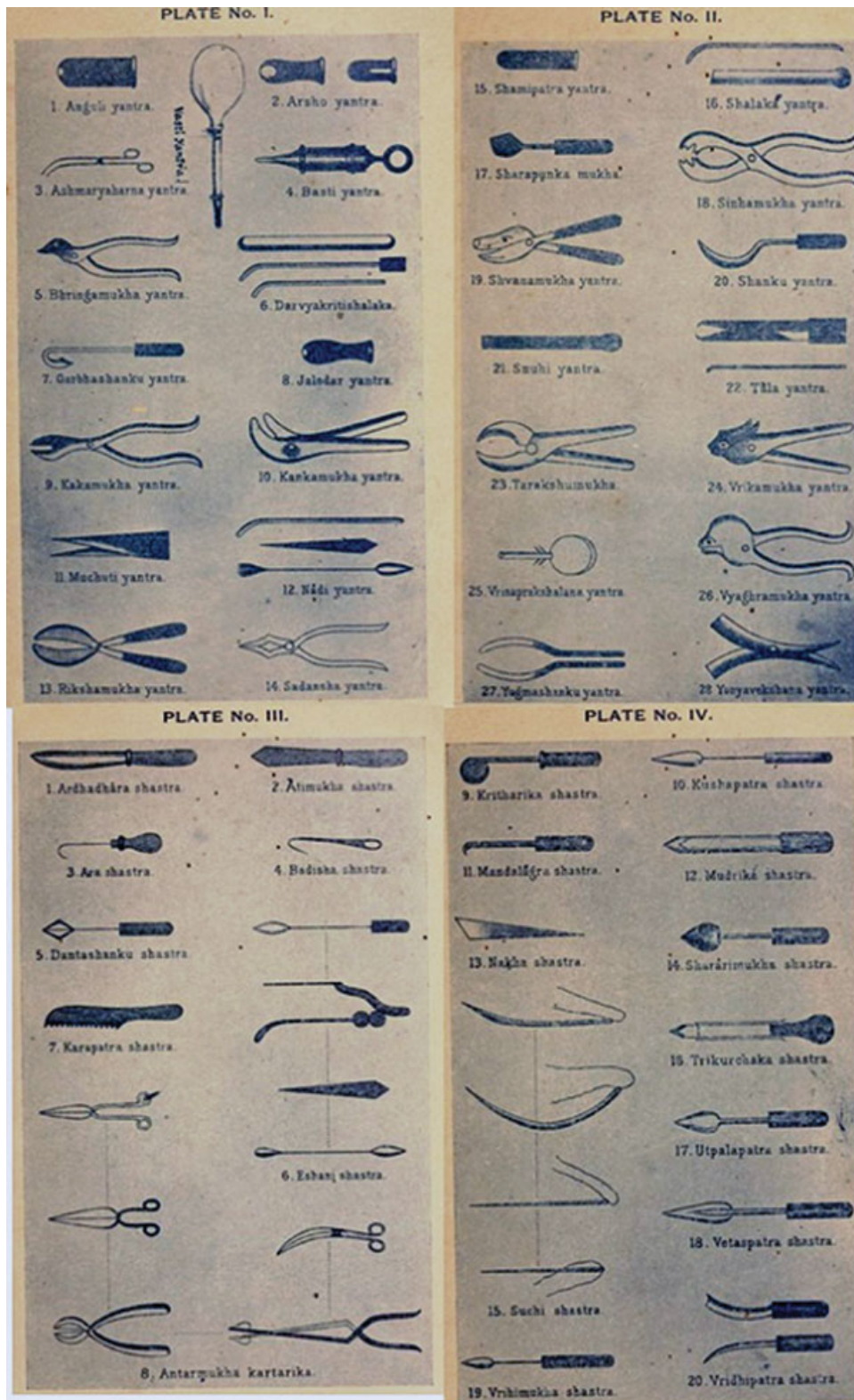


Fig. 5 An illustration of how Susruta's instruments may have appeared. The illustrations, found in Bishnagatra's English translation of the *Susruta Samhita*, are based on Susruta's descriptions of his instruments. The instruments resembled the mouths of birds and animals. The "sinha mukha," or lion-mouthed tong is similar to Lane's bone holding forceps used by orthopedic surgeons. The "vyagramukha yantra," or tiger-mouthed tong and "kankamukha yantra," or her on beaked tong, are other examples of his instruments (Bishnagratna¹¹).

Susruta's Neurosurgical Techniques

Along with his advances in the fields of plastic surgery, ophthalmology, and urology, Susruta has been touted as an innovator in the field of neurosurgery. According to Banerjee et al:

[Susruta] dwells on surgical procedures involving the head and pertaining to the cranial structures, mainly dealing with warfare injuries, including trephining, excising, probing, puncturing, suturing, and evacuating 'collected' fluids.⁶

This would indicate that Susruta had developed neurosurgical methods and procedures dealing with head trauma and probably evacuation of intracranial hemorrhages. The trephined skull from Kashmir discussed earlier provides evidence that others before Susruta had made attempts at gaining access to the cranium, but Susruta's procedures would be one of the first mentions regarding the early management of neurosurgical trauma.

Furthermore, Susruta had a far advanced understanding of the nervous system, as can be attested by his descriptions of the afferent and efferent nerves:

The ten up-coursing dhamanis (nerves) perform such specific functions of the body, as sound, touch, taste, sight, smell, inspiration, sighing, yawning, sneezing, laughter, speech and weeping etc. and tend to maintain the integrity of the body...The down coursing dhamanis respectively form the channels for the downward conveyance of Vayu (flatus), urine, stool, semen, and catamenial fluid, etc.¹⁷

And finally, his description of the cranial nerves demonstrates how he meticulously studied the neuroanatomy of both his patients and his educational cadavers:

Two nerves lower down at the back of ear (vidhura) which if cut produce deafness; a pair of nerves inside the two nostrils which if cut cause anosmia; a pair of nerves below the end of the eyebrow which if cut causes blindness.¹⁷

The surgical knowledge and skill set can be attributed to the number of wars and small battles that took place during the Vedic period. Soldiers were injured with weapons such as arrows, swords, and maces. Surgeons had to be skilled in removing foreign objects, controlling hemorrhage, and dressing wounds.²⁴ To surgically intervene in these traumatic injuries to the head, Susruta had to innovate new tools and techniques.

To achieve hemostasis in highly vascular regions of the body such as the cranium, Susruta described the use of cautery years before Hippocrates and Abulcasis as described in the Hippocratic Corpus²⁷ and Kitab al-Tasrif, respectively.²⁸ Susruta writes:

A fire (cautery) is better than an alkali as far as its healing property is concerned... A burning of the skin is

accompanied by a peculiar bursting or cracking sound. The skin becomes contracted and emits a fetid smell. Similarly, in a case where the flesh is burnt, (the affected part) assumes a dove color of (blackish brown), marked by pain and little swelling, and the incidental ulcer becomes dry and contracted...The regions of the eyebrows, forehead and temple bones, should be cauterized in diseases affecting the head as well as in a case of Adhimantha (Ophthalmia).¹⁷

On the basis of these writings, Susruta was aware of the vascularity present in the cranium, and had utilized cautery to prevent the patient from exsanguination. Susruta's descriptions of the pathologies "affecting the head" and nervous system, anatomical descriptions, and management of hemorrhage demonstrate his far advanced understanding of the nervous system and the management of neurosurgical trauma.

Conclusion

The *Susruta Samhita* ushered Indian medicine from a period of magical and supernatural thinking to one based on direct studies and observations. Susruta's writings demonstrate his knowledge of numerous surgical procedures, including those providing neurosurgical treatment. In addition, Jivaka, the personal physician of Buddha, performed craniotomies on his patients that suffered from intracranial lesions sometime during the 5th century BC.²⁹ The number of surgical accomplishments and advancements made by these ancient Indian physicians is plenty. One reason why writings from the Ancient India may not be as extensive as those found later in antiquity, is that most writings were passed down as verses committed to memory. This form of communication would keep descriptions to a minimum. Several historians have also commented upon the influences Indian medicine may have had on Hippocrates, Galen, and other early Western physicians.²⁴ Historian Johnston-Saint writes:

A disproportionate part of our education was devoted to ancient Rome and Greece where we learned all about Apollo and Aesculapius and in Greek history we come to Hippocrates. Here we had got a founder of medicine already for us and that there might have been anyone before him, few of us were disposed to inquire.³⁰

Susruta's studies, instruments, and procedures were developed and written many years before those of prominent Western pioneers in neurosurgery, including Hippocrates and Galen. Regardless of whether he had a direct influence on these two prominent Greek physician scientists, the advances made by Susruta in the field of surgery, neurosurgery in particular, deserve to be recognized.

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Disclosures

None.

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