

Author

Dr Lois Hamlin
DNurs, RN, FACN, FACORN

The first three procedures that marked the dawn of surgery

Abstract

Archeological studies reveal that humans splinted fractures and operated on skulls. Other than dealing with wounds or fractures, early surgeons carried out three types of operative procedures – circumcision, trephination and lithotomy. The first two procedures are the most ancient, for it is hypothesised they were undertaken between 10 000 and 15 000 years ago. Circumcision was a religious, fertility or initiation rite or ritual and trephination was done for mystical as well as therapeutic purposes. In contrast, lithotomy commenced much later, between the 4th and 5th centuries BCE and therefore did not occur prehistorically. However, it is the first operation that was performed to relieve a specific surgical condition.

Introduction

An earlier paper¹ published in JPN outlined the beginnings of perioperative nursing, which had its genesis in surgical nursing about 150 years ago. This exploration of nursing's first specialisation prompted reflection on the history of surgery, a craft whose pedigree stretches back to the dawn of humankind. This paper does not intend to provide even the briefest outline of this history, for it is not possible in such a small compass. Instead, the focus is on the three earliest known 'elective' interventions that date back many thousands of years and which are still performed today.

The word 'surgery' is derived, via the Latin *chirurgia*, from the ancient Greek *χειρουργία* (kheirourgia) and means hand work². Our innate instinct for self-preservation no doubt drove us to seek help if we couldn't help ourselves. As far back as, possibly, a quarter of a million years ago, our prehistoric ancestors were being treated for injuries and diseases by primitive 'healers', those among our forebears who had a particular aptitude to carry out such activities³. Clearly, these treatments occurred long before the advent

of the written record, that is, in prehistoric times. The term is mostly used for the period from 12 000 before the common era (BCE) to 3000 BCE – roughly speaking, the Neolithic age. Our understanding of events of that time is derived from archaeology and its associated study of tools, bones, buildings and cave drawings.

Archaeological excavations revealed ancient skeletons that had sustained fractures (caused by accidents, falls and animal or human attacks) and showed evidence of bone disease, even rotten teeth³. It is hypothesised that injuries were variously treated and dressed, based on the early studies of primitive tribes from the beginning of the 20th century⁴. Australian Aborigines encased broken arms in clay, which hardened in the sun, and covered cuts with animal fat then bound them up with bark or animal skin⁴.

Elsewhere around the globe, primitive tribes used leaves and plants, cobwebs (which may well have some blood clotting properties), ashes and even cow dung on open wounds³. More robust evidence of broken limbs being splinted and of wounds being dressed with lint date from about 2450 BCE and came from Egyptian excavations³.

However, the management of these broken limbs or open wounds is not under scrutiny here, as noted earlier. Instead, it is the work of those early ‘surgeons’ who carried out three types of operative intervention – circumcision, trephination and lithotomy^{3,5,6}. Although circumcision is thought to be the most ancient of the three, there is some evidence that trephination was practised at least as early and possibly earlier³. It begs the question, why were these procedures performed?

Circumcision

Anthropologists cannot agree on the origins of circumcision (removal of some of the foreskin, or prepuce, from the penis⁷), nor how long it has been in existence, perhaps because the practice has occurred in such geographically disparate regions around the globe. It has been suggested that it is one of the features of a ‘heliolithic’ culture which, over 15 000 years ago, spread over much of the world⁷.

Circumcision has been practised among primitive communities in Australia, South America, the South Pacific, equatorial Africa, Turkey, Egypt and the Middle East. It is known to have been practised by priests’ assistants on the priests and members of royal families in Egypt between 2400 and 3000 BCE³. A bas relief from the sixth dynasty (4300 years ago) on the sarcophagus of Ankh-ma-Hor at Saqqara shows male circumcision being practised on two boys or young men as a ritual prior to entry into the priesthood (Figure 1). In it, a crude stone instrument is employed by the operators and the inscription has them saying, ‘hold him so that he may not faint’ and ‘it is for your benefit’.

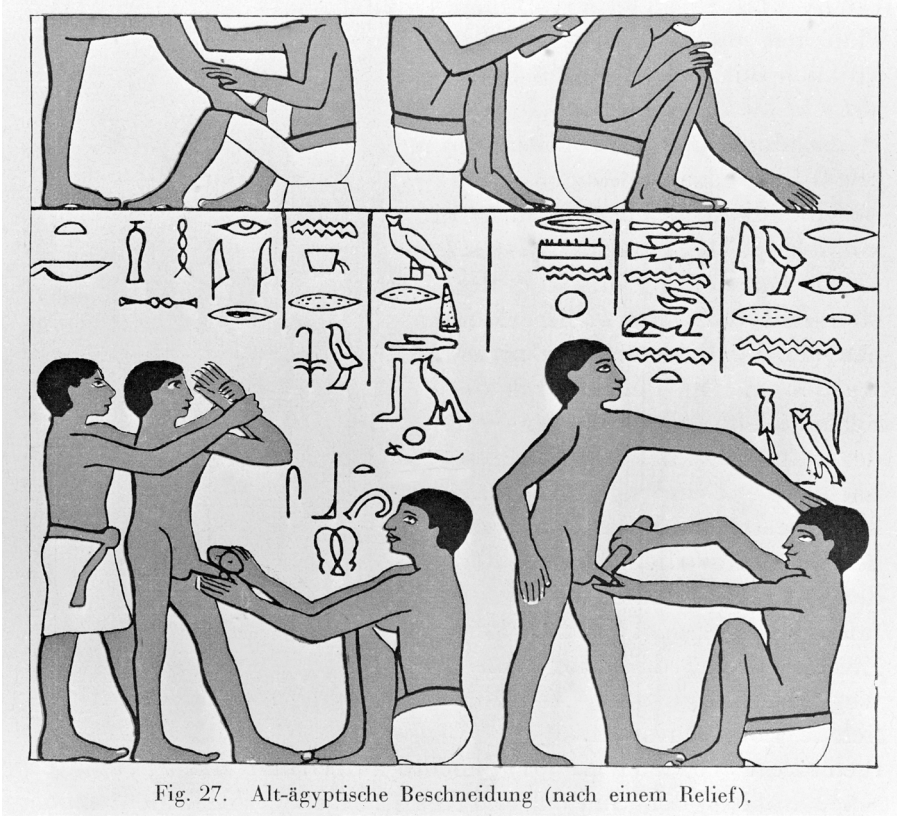


Fig. 27. Alt-ägyptische Beschneidung (nach einem Relief).

Figure 1: Figures showing a circumcision

(Source: Wellcome Collection Gallery. This file comes from Wellcome Images, a website operated by Wellcome Trust, a global charitable foundation based in the United Kingdom. Refer to Wellcome blog post (archive).)

In some African tribes it was performed at birth; in Judaic societies, male circumcision is linked to a covenant with God dating back to Abraham⁸ and is completed on the eighth day after birth. Among Moslem peoples of India and Southeast Asia, and other tribal cultures, it occurred in early adult life as a rite of passage⁷.

It has also been practised as a form of punishment inflicted upon those who were not circumcised, sometimes during battle; in Koranic times, the slashed prepuces of ‘unbelievers’, collected following a battle, were held up as trophies of victory⁸.

Other reasons proffered for undertaking circumcision include:

- as a fertility rite⁷
- to maintain hygiene and cleanliness³
- as a form of social control⁸
- as a form of cultural identity⁷
- as a sacrifice to the gods⁷
- as a mark of defilement or slavery⁷
- to dampen sexual desire and limit sexual intercourse⁹.

Techniques and practitioners of the ‘procedure’ were diverse. In biblical times, the mother performed the circumcision but over time it largely fell within the remit of religious men. In ancient Egypt the procedure was performed by the priest using his thumbnail (often gold impregnated) but in due course circumcision knives and other instruments were devised for the operation (Figure 2)⁷.

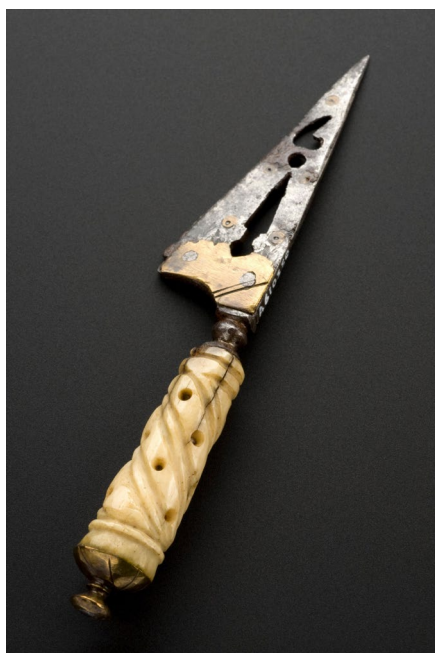


Figure 2: Circumcision knife, Europe, 1775–1785

(Source: Science Museum London. Reproduced under [licence](#))

The ancient Greeks and Romans abhorred the practice of circumcision, believing it to be primitive, barbaric, arising from superstition and a means of oppression⁸. One Hellenistic Greek, King Antiochus IV Epiphanes, outlawed circumcision and those mothers who had their infants ritually circumcised were flogged, crucified or stoned⁸.

Circumcision continues to be performed today, in many echelons of society, in developing and developed countries¹⁰ and for religious, ritualistic or medical reasons¹¹. The purpose of the procedure determines when it is undertaken, vis-a-vis the age of the patient. It remains a controversial procedure and, for example, the Canadian Paediatric Society recommends that circumcision of newborns should not be routinely performed¹⁰, as does the British Medical Association¹². In contrast, the American Academy of Pediatrics indicates that the health benefits of newborn male circumcision outweigh the risks and, further, the

procedure's benefits justify access to it. Specific benefits identified include prevention of urinary tract infections, penile cancer and transmission of some sexually transmitted infections, including HIV^{13,14}.

Trephination

As long ago as 10 000 BCE³, possibly earlier¹⁵, boring or cutting out rings or squares of bone from the skull was practised and, remarkably, many survived this procedure³. The practice is known as trephination or trepanation and, although trephination refers to drilling whereas trepanation means scraping or cutting³, the terms are used interchangeably. Studies related to prehistoric trephination followed the discovery, in a prehistoric stone tomb in central France in the late 19th century, of a skull with a large artificial opening³ (Figure 3). Since that time many thousands of such skulls have

been found. It is also extraordinary that this complex procedure was undertaken in many different parts of the world^{3,15}, including the United Kingdom, Poland, Spain, Portugal, Scandinavia, the Caucasus, Palestine, the Western coastline of the Americas (especially Peru), North Africa³ and China¹⁶. Whether the procedure was practised in ancient Egypt appears to be contested¹⁷ although it was performed in ancient Greece. Trephination was still being practiced in isolated and primitive communities until the early 20th century¹⁸.

It is believed trephination was performed for the management of skull injuries and fractures³; however, the procedure was also carried out for other reasons, including:

- intracranial disorders
- chronic headache
- brain tumours
- other painful disorders^{3,16}.



Figure 3: A Neolithic (3500 BCE) skull showing evidence of trephination

(Source: World History Encyclopedia (by Jmh649). Reproduced under [licence](#)).

It was also believed the procedure had a magical and/or religious purpose, that of expelling evil spirits because our forebears thought these were the cause of mental illness, insanity and epilepsy. In parts of New Guinea, it was performed on youths as an aid to longevity³. Elsewhere the procedure was thought to confer magical powers on the patient and the pieces of skull retrieved were used as amulets, as they, too, were perceived to have magical properties³.

However, it appears most cases were done for therapeutic reasons. It was performed much more frequently on men, probably because they sustained far greater numbers of head injuries during tribal warfare. In some prehistoric cultures (e.g. in Peru) it was undertaken on men only¹⁹. Children were rarely the recipients of trephination¹⁵. In some cases, trephination was performed peri-mortem or immediately post-mortem, possibly for cultural or ritualistic reasons¹⁶, although it has also been hypothesised that post-mortem trepanation was a means of better understanding cranial anatomy and improving techniques¹⁹.

Scraping, supposed to be the oldest trepanning technique, involved the use of an abrasive stone tool which was rubbed across the skull surface until a perforation was obtained¹⁵. In terms of survival, it was also the most successful, probably because stone scrapers were more able to avoid accidental penetration of the dura mater. The areas of the skull most often operated upon were the parietal bone followed by the frontal, and the left side of the skull was involved more often than the right¹⁵. In some cases, the skull had been poly-trephined resulting in two or more holes^{3,15}.

How this operation was performed without the benefit of anaesthesia,



Figure 4: Skull trephining, ca 1594

(Credit: *Le chirurgie française recueillie des anciens médecins et chirurgiens. Avec plusieurs figures des instrumens nécessaires pour l'opération manuelle* / Par Jacques Guillemeau. Source: Wellcome Collection. Reproduced under [licence](#).)

haemostasis or antiseptics, as we know them today, is astonishing. However, management of bleeding from spongy bone would have been necessary and the use of plants or, in the case of ancient Greeks, cautery was used for this purpose¹⁵. The Incas of ancient Peru were expert naturalists and used extracts from coca plants and alcohol as anaesthetics, various roots and shrubs that are rich in tannic acid as haemostatics and certain mineral salts and chemicals for their antiseptic properties¹⁸.

The presence of early osteoclast activity, bone necrosis or hypervascularity indicated that in many cases the patient survived for at least several weeks; longer term survival was evidenced by extensive

bone remodelling²⁰. The survival rate for this procedure was impressive and generally believed to exceed 50 per cent²¹. In one study of 400 Peruvian trephinations, 62.5 per cent showed signs of healing¹⁸.

Identifying how these primitive surgical forebears acquired the necessary skills to undertake trephination is speculative. There is some evidence that Neolithic practitioners in Europe learnt their skills by practising on domestic animals²². In medieval Europe, it was not until the renaissance, and its associated burgeoning and dissemination of knowledge³, that more sophisticated trephining became evident (Figure 4).

Lithotomy

Circumcision and trephination were performed for various reasons – in the case of circumcision, these were religious, cultural or ritualistic. Similarly, although trephination was undertaken for therapeutic reasons, it was also performed for mystical purposes. In contrast, ‘cutting for the stone’ was undertaken for one reason only, thus it can be deemed to be the most ancient procedure for a single, specific, surgical condition³.

The most ancient bladder stone found to date was in the grave of a 16-year-old boy, in a prehistoric cemetery at El Amrah in Upper Egypt. It has been dated at 4800 BCE^{3,23}. The earliest writings about stone disease, describing symptoms and prescribing treatments to dissolve the stone, are found in the medical texts of *Asutu* in Mesopotamia between 3200 and 1200 BCE²³.

It is in Hindu and Greek writings of the 4th and 5th centuries BCE that the first descriptions of lithotomy are found. Sushruta was a surgeon who lived in ancient India and was the author of a book in which he describes over 300 surgical procedures, including perineal lithotomy^{23,24}. He described this operation in meticulous detail, exhorting surgeons to take special care to ensure they did not break the stone so that no pieces were left behind to grow large again²³.

Hippocrates (460–377 BCE) described diseases of the kidney and defined symptoms of bladder stones. In his oath of medical ethics for physicians, Hippocrates outlined that they were not to cut for the stone, but to leave it for practitioners of this work^{3,24}. At that time, lithotomy was practiced via a perineal incision and was done by special lithotomists²⁴. The Roman encyclopaedist Celus (25 BCE – 50 Common Era (CE)) described the

procedure of perineal lithotomy, and this approach persisted for the next 1500 years (Figure 5). It required that the patient be restrained, usually by a parent as Celus believed the operation should only be performed on children between the ages of nine and 14²⁴. The operator inserted two fingers of the left hand (dipped in oil) into the anus. The right hand was used to push down on the lower abdomen, pushing the bladder and thus forcing the stone into the grip

of the left index finger within the rectum. This caused the stone to bulge in the perineum. An incision was then made in front of the anus into the base of the bladder and the stone was pushed out by the finger in the rectum. If necessary, a hook was used to dislodge it. The wound was then dressed with wool and warm oil³.

Because the operation involved no special instruments, merely a knife and possibly a hook, it was known



Figure 5: Surgery operating for bladder stones

(Source: Wellcome Collection. Reproduced under [licence](#).)

as the 'operation minor' or the 'petit appareil'²⁵. It was carried out without the benefit of anaesthesia and often in public by itinerant, often uneducated, lithotomists who travelled from town to town seeking business²⁴.

In 1503 a new technique was introduced and, although similar to the 'operation minor', overcame the problem of identifying the bladder neck by the passage of a guide into the bladder along the urethra²⁵. Subsequently, a vertical incision was made in the mid-line onto a groove in the guide to open the urethra, which was then progressively dilated³. This process tore through the prostate gland and bladder neck. Stone holding forceps were then passed into the wound to remove the stone or, if it was too big, forceps were used to first crush the stone and the fragments then removed with a scoop or hook. This was known as the 'apparatus major' or 'grand appareil' because a large array of instruments was used^{3,24,25} (Figure 6). It gradually replaced the lesser procedure and was practiced widely throughout Europe for the next 300 years, despite the complications – haemorrhage, sepsis, incontinence and impotence – all of which were common occurrences³. A final refinement to the perineal approach was the lateral lithotomy, which was still being performed up until the 20th century³ although by then with the benefit of anaesthesia.

The first successful removal of calculi via a suprapubic approach was described by Pierre Franco in 1561²⁴. However, he advised others not to follow his example and many surgeons took his advice believing that there would be dire consequences. Nonetheless, it began to be carried out successfully first in France and then in England in the

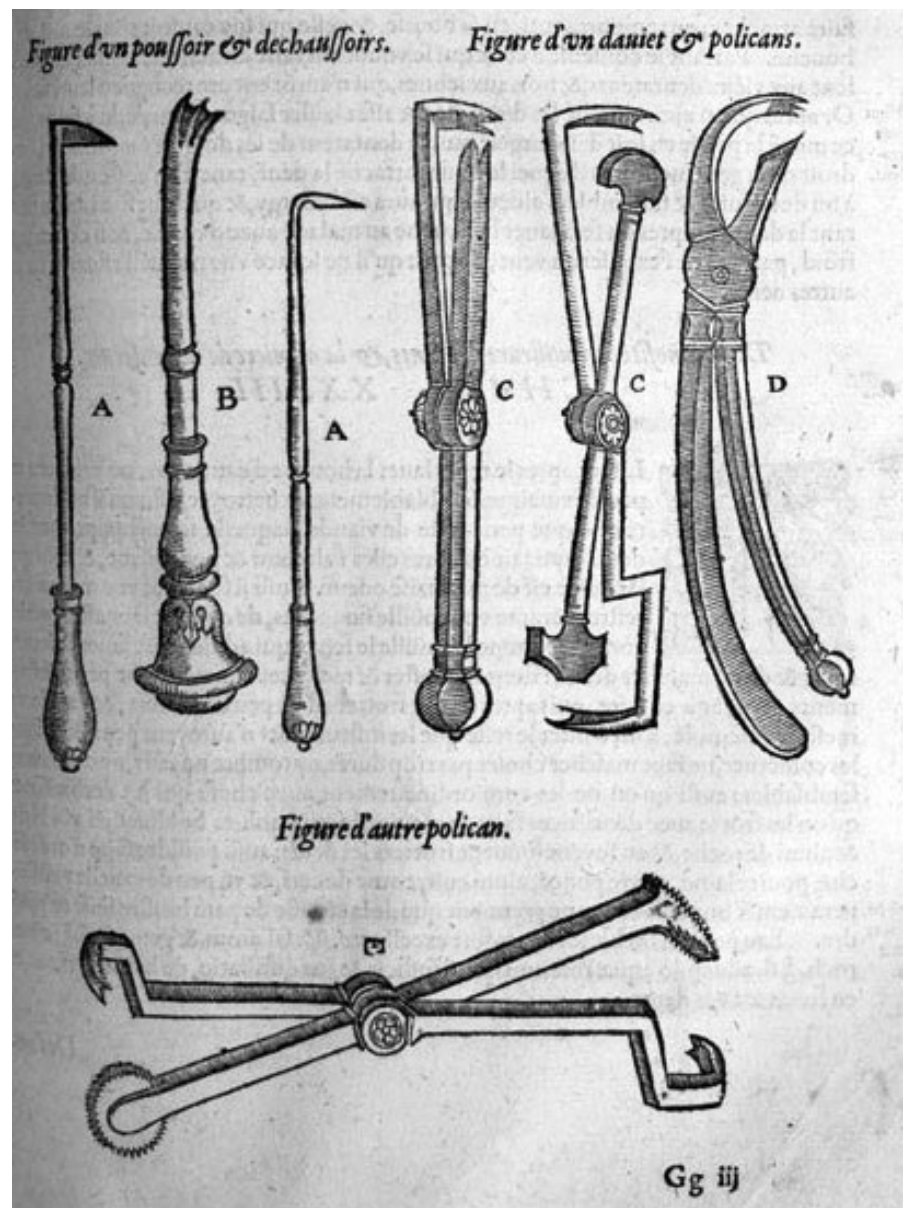


Figure 6: Instruments of Ambroise Paré, 1585

(Source: Historical Medical Books at the Claude Moore Health Sciences Library, University of Virginia.)

18th century. When the surgeon John Douglas realised that the bladder could be opened extra-peritoneally above the pubis when distended with fluid he published a book about it in 1720^{3,25}. In it, he listed the advantages:

- it was easier for the patient
- it could be accomplished rapidly
- a cure was more certain

- the approach prevented urinary incontinence, impotence or the formation of fistulae³.

Despite these improvements, the procedure had a high mortality rate, was performed infrequently and only in cases of large stones. It was not until the end of the 19th century and the many advances occurring in 'modern' surgery – asepsis and

anaesthesia – that the procedure became safe and routine.

Currently, various new technologies have been developed in the effort to make bladder stone treatment less invasive²⁴. Stone fragmentation (lithotripsy) can be achieved by using several surgical approaches and devices²⁶. However, bladder stones are now rare²⁶ – mainly seen in developing countries – and eventually they may disappear completely³.

In summary, an exploration of the earliest operations humans performed shows they stretch back through millennia. Circumcision is possibly the oldest procedure, and the one performed most often and mostly consistently throughout history. It seems to have been undertaken for a plethora of reasons – cultural, religious and medical – and remains a controversial procedure still practiced extensively today. Trephination is the most intriguing procedure performed by our ancestors, given the nature and complexity of such an undertaking, even in the 18th and 19th centuries. It was undertaken for mostly therapeutic purposes; however, in some instances there were mystical reasons associated with it. It, too, continues to be practised today, albeit in such a vastly different way as to be unrecognisable in comparison with its earlier origins. Lithotomy or ‘cutting for the stone’ was the only one of these procedures that was performed for a sole purpose, and almost always as a last resort. It is also the only procedure that is currently in decline and may even cease to be performed at some point in the future.

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