

Perceptions of Amputation before and after Gunpowder

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Summary

Woodall's remark on limb amputation, in 1617, that "it is no small presumption to Dismember the Image of God", reflected lingering doubts attributable to widespread ancient beliefs or taboos which, at least during the early historic period, shunned elective amputations completely. Death was preferred to operative destruction of the body's integrity, even when societies were aware of traumatic, disease-induced and legal amputations, eventually to be accepted and managed rationally. Deep-rooted resistance to planned dismemberment became unbalanced by the malevolent wounds of gunshot missiles which contrasted vividly with cold steel and blunt injuries of earlier warfare. Massive soft tissue destruction, bone comminution and, above all, embedded missiles and clothing posed perplexing complications for both patients and surgeons, often causing gangrene and death. Finally despite resultant deformity, amputation was recognised as a means of preserving life. It is maintained the philosophical perception, believing it is better to live with three limbs than to die with four, gained acceptance due to the persuasive influence of gunpowder on battlefields and in battle-ships. Notwithstanding, until carbolised catgut ligatures were employed amputation remained a hazardous procedure; it persists as a repugnant operation of last resort.

Résumé

A propos de l'amputation des membres, Woodall écrivait en 1617 que c'était pure arrogance de démembrer "l'Image de Dieu". Cette remarque reflétait des doutes attribués à d'anciennes croyances ou tabous très répandus, qui s'opposaient à ce type de chirurgie. On pré ferait la mort à la destruction de l'intégrité du corps par opération, même lorsque l'amputation était due à des accidents, des maladies ou des punitions. Cette résistance psychologique contre les amputations a diminué lorsque les mauvaises blessures par balles ont remplacés les blessures plus simples provenant d'armes blanches. La destruction massive des tissus mous, la pulvérisation des os et surtout les missiles et les lambeaux de vêtement enfouis dans le corps rendaient la situation des blessés très pécaire et le chirurgien devait faire des choix difficiles car l'évolution se faisait souvent vers la gangrène ou la mort. Finalement, l'amputation fut acceptée comme moyen de préserver la vie malgré tous ses problèmes. La croyance qu'il valait mieux vivre avec trois membres que mourir avec quatre se répandit grâce à la force de persuasion des plaies d'armes à feu sur les champs de bataille et sur les bateaux de guerre. Néanmoins, l'amputation resta une intervention risquée jusqu'à l'utilisation des ligatures au catgut phénique. L'amputation est encore de nos jours une opération répugnante seulement pratiquée en dernier recours.

The amputation of a limb is an operation terrible to bear, horrid to see, and must leave the person on whom it has been performed in a mutilated imperfect state; but still it is one of those which becomes, in certain circumstances, absolutely and indispensably necessary

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Pott (1779)

Introduction

Mankind's familiarity with natural limb amputations secondary to congenital defects, frostbite and vascular failure is, credibly, as ancient as the human race. Ultimately these and the spontaneous healing of traumatic amputations due to domestic, hunting and battle injuries encouraged acceptance of the amputee, at least in some communities. Much later guillotine excision of hands and feet was established as a punishment of prisoners-of-war and, in certain societies, formalised as a penalty for law breaking. More problematical is the pre-historic approach to incomplete severance; it is possible trailing limbs were lopped off by friends, or more likely by the victim as described in the First World War by Duhamel (1917). Even more mysterious is the initiation of elective amputation, that is the sectioning of sound tissues in order to excise diseased and injured appendages radically. In any event injuries severe enough to suggest major amputation, in order to forestall death, were uncommon throughout the historic era until the 16th century, certainly in Europe when, it is argued, gunshot injuries precipitated a total change in surgical outlook.

Perceptions of amputation varied with individual view-points adopted by patients and surgeons at a perilous moment of crisis, yet both were influenced powerfully by traditional attitudes exercised by the society in which they lived. Some societies regarded dismemberment as a last desperate resort to preserve life whereas others, restrained by taboos and religious convictions to preserve bodily unity, ensured elective amputation never took place; death from a gangrenous limb was accepted more readily than elective mutilation of the human corpus. And, if by chance a limb healed after a severe compound wound, this was regarded as a triumph, even when wound healing took many years and subsequently the limb remained functionless (Hilton-Simpson 1922).

In practice it is easier to find historical accounts of an individual surgeon's perception of amputation than those of patients and their communities, although often the surgeon ventilates all three viewpoints. John Woodall's (1617) comments in 1617 are an example. He wrote :

Amputation or Dismembering is the most lamentable part of chirurgery, it were therefore the honour of a Surgeon never to use dismembering at all if it were possible... For it is no small presumption to Dismember the Image of God.

and, he added

This worke ... is best to be done in the morning, doe it not willingly the signe being in the place, neither the day of the full moone...

This summarises personal doubts and expresses society's astrological superstitions surrounding the risks and gloomy finality of the procedure. But Woodall continued :

... necessitie hath no law; the Patient will declare in his naturall desire to live, the comfort that hee hath by it. Since therefore it is of necessary use, let the discreet Surgeon be ever prepared for it.

Thus, in early 17th century Britain, neither patient nor surgeon were constrained by fundamental sanctions against amputation, for life was crucial, irrespective of the resultant operative mutilation. In reality, Woodall was keener to amputate gangrenous limbs than to section living tissues and prevent gangrene, a topic to which we will return.

Before Gun Shot Injuries

The ancient stele inscribed with the law code of Hammurabi, circa 1750 BC, is dramatically impressive for stipulating that when operations ended fatally, the hands of the surgeon responsible would be cut off as a punishment

(Sigerist 1951). Could this be the first written record of dismemberment for any purpose ?

If the Smith and Ebers papyri, and other documents of ancient Egypt offer no account of surgical amputation (Ghalioungui 1983) the Samhita Sushruta (Bishagratna 1907-1911) of ancient India advised amputation as high as the wrist and ankle for deeply embedded thorns in the hands and feet. In the 9th century BC, Homer's *Iliad* described in outline one hundred and forty one injuries among the mythical war heroes, including traumatic but not elective amputations (Daremborg 1865); probably this reflected the state of actual battlefield wound care in Ancient Greece. Some commentators believe the early Greeks shrank from major limb amputation primarily because of inability to stem fatal blood loss (Cooper 1822).

By the 4th century BC, Hippocrates (Adams, 1849) and other early classical authors noted gangrenous limb separation and assisted this slow process by incision between dead and healthy tissues. If we ignore minor amputations of injured fingers and toes (Milne 1907), removal of gangrenous tissue was the only form of major dismemberment recognised until Celsus (Spencer 1938), in the 1st century AD, mentioned vessel occlusion between ligatures and hinted at elective amputation, proximal to gangrenous tissue. Heliiodorus and Archigenes (Lund 1936), contemporaneous with Celsus, reflected similar attitudes and observed that ulceration, tumour formation, deformities and trauma, in addition to established gangrene, were appropriate indications for dismemberment. No classical authors however record conclusive amputation for trauma through healthy tissue in order to frustrate gangrene and death. And despite the work of Celsus, both Galen in the 2nd century AD and Paulus (Adams 1846) in the 7th century, resumed Hippocratic practices of restricting amputation to dead tissue.

In general, Arabic authors continued this conservative approach, making considerable use of heated cauteries to dry up gangrene. However Albucasis (Spink & Lewis 1973a), of the 10th century AD, was prepared to amputate as high as the knee and elbow joints for dangerous bites of marine scorpions, vipers and venomous spiders, utilising cautery to control haemorrhage. Yet when faced with a patient who requested amputation of a gangrenous hand, a probable case of ergotism, Albucasis refused to help as he feared operation would result in death; he reported the patient later cut it off himself, and concluded (Spink & Lewis 1973b):

I narrate this story as help against this kind of malady when it occurs; and as guidance for you to take and act upon.

This suggests Albucasis accepted a personal error of judgement and, at the same time, demonstrates the desperation of patients motivated to undertake their own operation in certain circumstances.

The surgeon's fear of uncontrolled bleeding and death of the patient being attributed to his interference pervaded surgical philosophy throughout the Middle Ages. This undoubtedly retarded the acceptance of prophylactic amputation. A case history such as the following is rare. Usmah (1929), a 12th century Arabic writer, reported a physician of the Lebanon treating a crusading knight for a leg ulcer by poultice. Despite apparent success, a Frankish physician interfered asking the knight if he preferred to live with one leg or die with two ? When he replied one leg, the physician called for an axeman who laid the leg on a block of wood and amputated the limb after two blows, the first having failed to sever the bone; it is considered the knight died of blood loss.

Mediaeval surgical authors who discuss elective amputation, unfortunately fail to offer

evidence of personal experience, thus in 1363, Guy de Chauliac (Joubert 1659) noted the need for amputation and disarticulation mentioning razor, saw, cautery and boiling oil, only to add he did not amputate himself as he awaited natural limb separation.

Trauma prior to gun-shot injuries was much less devitalising to limbs and the question of elective amputation was rarely posed. After cold steel injuries Wiseman (1676a) indicated amputation was not routine even with multiple wounds. He stated :

I shall now consider of Wounds with loss of substance made by Bill, Pole-axe, Sword, etc. some cutting twice or thrice in one or near one place ... in the Wars they are frequent, especially when the Horse-men fall in amongst the Infantry, and cruelly hack them; the poor Souldiers the while sheltering their Heads with their Arms, sometimes with the one, then the other, until they both be most cruelly mangled.

He concluded these mangled limbs eventually healed even if neglected and digested by maggots; he does not debate the inevitable major nerve and tendon defects of such injuries. And Bell (1812) stated in 1812 :

... flesh wounds with the bayonet, or sword, or sabre, are less dangerous than gun-shot wounds ... there is no painful searching for foreign bodies, nor any slow exfoliation of bones; there is neither any danger from too high an inflammation, nor any great risk of gangrene.

After Gunshot Injuries

The introduction of gunshot missiles in 14th century Europe slowly displaced arrows and slingshot, to change the fundamental nature of battle injuries. Initially concern was expressed that blackening of the tissues by gunpowder, due to obligatory weapon discharge at close

range, was a source of "poisoning"; this being offered as an explanation for the malevolent appearance and behaviour of these novel wounds. Removal and neutralisation of the poison by simple lavage and later by instilling warm or possibly boiling oil was viewed as a key step in management (Wangenstein, Smith & Wangenstein 1963).

As the velocity and efficiency of the new weapons increased, the ratio of gunshot to cold steel injuries changed. At first surgeons were perplexed by wounds caused by cannon balls, chain shot and large wooden splinters (derived from the rending of battleship timbers) which produced massive soft tissue damage, combined with comminuted open fractures contaminated by indriven clothing, armour, missile material, bone and wood. As these wounds were not blackened by gun-powder, surgeons concluded, eventually, that embedded foreign bodies were the source of lethal complications and should be extracted. Lacking anaesthesia, extractions were often incomplete thus failing to prevent infection and death. Early in the 16th century such wounds, especially where main arteries and joints were involved, persuaded many military surgeons to dismember through healthy tissue before complications arose, at least below elbow and knee joint levels.

In 1517 Von Gersdorff (Zimmerman & Veith 1967), the first author to illustrate limb amputation warned :

If the limb must be cut off, and nothing else will help, ... you should advise the patient above all to go to confession and receive the Holy Sacrement on the day before you ampute. And if the surgeon hears Mass before operation, God will favour his work.

This emphasised the surgeon's concern to inform both patient and society of the gravity of major dismemberment whose outcome hinged on religious observances.

Later in the 16th century, as a result of the work of Pare (1575) and others, primary amputation became the recommended solution for severe gunshot wounds to save life; slowly this advice extended to compound fractures of whatever cause. Even so Clowes (1596) in 1596 reminded his surgical readers that the patients :

... have ministered unto them some good exhortation, concerning patience in adversitie, to be made by the minister or preacher. And you shall likewise advertise the friends of the patient, that the worke which you go about is great, and not without danger of death.

If not always expressed, the fears of cruel pain during amputation, of death from blood loss or from subsequent sepsis, and anxieties about the quality of the stump and future rehabilitation were implicit in the calculations of both patient and surgeon, even when the appearance of amputees was accepted by society.

However not all surgeons and few patients were comfortable with radical solutions as Woodall's approach demonstrates; he reviewed two diagnostic situations. Firstly, patients with established gangrene who could be dismembered at leisure through insensitive dead tissue without bleeding; this reflected specialised experience at St Bartholomew's Hospital, London where he recorded a hundred or more such amputations. And secondly, patients with grossly shattered limbs, usually due to gunshot who required urgent limb amputation through sound and sensitive tissues (Woodall 1639). Woodall offered no case observations of the latter in contrast to several examples of gangrenous trimming.

Few colleagues were able to follow Woodall's cautious counsel, for few had access to hospital beds to monitor the gangrenous process and its slow separation, which often occupied many

months. Moreover, on ships and battlefields this approach was impossible and neither surgeons nor their patients could limit their problems to the morning or avoid the day of the full moon.

As Wiseman (1676b) made clear, the patient often initiated and indeed insisted on dismemberment in certain circumstances. Clearly, repeated dressing and splinting of a shattered leg was painful enough without the erratic movement of a sailing ship in all weathers, and the hazard of the limb being nibbled by rats, such prospects crystallised the demand of many sailors for immediate amputation in return for greater freedom of movement and earlier resolution of pain, assuming all went well. Experienced soldiers too were aware when amputation seemed the rational solution. Even children might plead their case as Ryder described in 1685. his patient was the nine year old son of a lawyer, whose leg was crushed by a cartwheel four years previously. Confined to bed, emaciated, his knee dislocated with the heel stuck to his buttock and eleven discharging fistulae, Ryder (1685) feared to suggest amputation and hinted there was no cure. To which :

The boy very heartily replied, he knew he should be well if I would cut off his thigh and if I would lend him a knife, he would cut it off himself.

Duly encouraged, Ryder performed above knee amputation; happily, the stump healed and the boy regained weight and good health.

By the end of the 17th century, society and surgeons generally approved of early amputation for shattered limbs, delay being considered a source of early death or many months of painful and uncertain healing in miserable hospital conditions. During the 18th century dissenting surgical opinions were voiced as wound-care was analysed more closely; a case in point is the compound tibial fracture suffered by Pott, the well-known London surgeon, saved

by a colleague from the proposed amputation. An extreme view was adopted by Bilguer who campaigned against elective amputation in a monograph of 1761 entitled *A dissertation on the inutility of the amputation of limbs*. This was based on observations that some patients who refused amputation survived and by his experience in a large Prussian military hospital where, systematically, gunshot wounds were explored, enlarged and excised. This necessitated repeated painful incisions and dressings and, for leg wounds, long confinement in bed; nine or ten months in hospital was not uncommon. Indeed Bilguer (1764) commented:

... this method of curing limbs ... is accompanied with a great deal of pain, with murmurs and impatience on the part of the sick; that it requires a very judicious surgeon, and gives him abundance of trouble, care and anxiety; besides I do not pretend that every patient was saved by it.

Conditions for this approach rarely obtained on battleships or on moving battlefields; for example in the French army advancing to and retreating from Moscow where the epic amputation feats of Larrey are frequently quoted (Dible, 1970).

Nevertheless Bilguer provoked a fierce debate which probably moderated extreme views and encouraged statistical studies. On the basis of modest field experience, Hunter (1794) was among those who counselled against primary amputation, yet accepted a delayed procedure if necessary.

In practice, striking the balance was never easy, for individual wounds and circumstances varied widely. As Gross (1862) concluded in 1862:

The cases which may reasonably require and those which may not require interference with the knife are not always so clearly defined as not to give rise, in very many

instances, to the most serious apprehension... that, while the surgeon endeavours to avoid Scylla, he may not unwittingly run into Charybdis, mutilating a limb that might have been saved, and endangering life by the retention of one that should have been promptly amputated.

The military surgeon Hennen (1820) maintained that his patients attributed surgical dismemberment to the fire of the enemy rather than the incision knife. Certainly soldiers and sailors generally continued to accept amputation as realistic treatment, as did an increasing number of the civil population exhausted by chronic bone ulcers, tuberculous joints and tumours.

Benefiting from general anaesthesia during the 19th and 20th centuries, surgeons initiated numerous alternative procedures to circumvent amputation. For example, joint excision for disease, ligature for aneurysm, trephine decompression of deep bone abscesses, improved fracture splintage, antiseptic and ultimately aseptic wound care, Xray localisation of foreign bodies, arterial reconstruction, blood transfusion, open debridement and closed plaster casts, antibiotic therapy, helicopter evacuation, bone tumour excision and its prosthetic replacement. As Schadewaldt (1974) observed, amputations composed 1 % only of all operations in 1974 compared to 20 % in 1860.

Unhappily the velocity and destructive nature of gunshot missiles has increased with time and escalated the menace of wounding. According to Aldea and Shaw (1986), the incidence of amputation at 2 % in the First World War, increased to 5.3 % in the Second World War, and to some 13 % in the Korean and Vietnam Wars. In current civil wars, traumatic and elective amputations of lower limbs are fuelled by the indiscriminate dispersal of anti-personnel mines, especially in parts of Africa and in Afghanistan (Coupland 1992). Happily

the death rate after elective amputation has dropped markedly from up to 70 % for thigh section at the battle of Waterloo to 40 % in the American Civil War and to single figures in recent conflicts (Aldea & Shaw 1986).

Modern anaesthesia, asepsis, transfusion, antibiotics and vessel reconstruction have reduced operative hazards dramatically and, as the wheel has turned full circle, now promote the re-attachment of traumatically severed limbs. The same expertise permits safe dismemberment of the elderly with vascular failure and gangrene, now accepted as obligatory in many parts of the world.

Conclusions

1. Concepts of Society

The approval of society at large is desirable, if surgeons are to advise confidently and patients accept willingly dismemberment as a means of survival. Until the Renaissance the indications for such surgery were few and often inhibited by religious constraints. If the fear of death from haemorrhage during amputation haunted Greek, Roman and Mediaeval authorities, other societies considered the maintenance of bodily integrity more important than merely preserving life. Coupland (1992) after recent extensive experience of war wounds in Red Cross hospitals confirmed the continuance of this attitude in some cultures, stating :

The patients may prefer a useless limb to a functioning prosthesis, whilst others may prefer to die from their wounds rather than suffer amputation. Such views must be accepted and accommodated in decision making.

Paradoxically members of the same cultures accept legal amputations as a punishment, presumably to stigmatise the law-breaker.

2. Fears of the Patient

Until the introduction of general anaesthesia about 150 years ago, the pain of incision and the application of both cautery and ligatures terrorised many patients. Parallel fears of death from complications such as haemorrhage and infection, only diminished when wound antisepsis and asepsis were established barely a century ago. Meanwhile acceptable solutions to anxieties over long-term functional prospects were delayed until very recent advances in rehabilitation and light-weight cosmetic artificial limbs.

Even so the fear and distaste of mutilation persists in all societies, to differing degrees, although many conclude it is better to live with three limbs than die with four.

3. Concerns of the Surgeon

Gunshot missiles produced mysterious wounds which, surgeons discovered eventually, needed drastic and unpleasant measures; from this evolved modern tourniquets, new instruments and novel techniques, and also a specific surgical philosophy which accepted limb sacrifice to preserve life. If today the correct indications and the levels of section remain matters for significant concern and debate, especially after trauma, the control of bleeding, infection and healing are now matters of surgical routine.

Nonetheless surgeons amputate with repugnance as a procedure of last resort, some harbouring, subconsciously at least, a sense of surgical defeat. Indeed the spectre of Bilguer has reappeared, as protracted efforts to save limbs are pursued, when prompt amputations would have been judicious. In addressing this dilemma, the annual Watson-Jones Lecture of the Royal College of Surgeons of England in September 1994 was entitled aptly, "Limb salvage versus amputation: technique over reason ?".

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*** This paper was read at the 34th International Congress on the History of Medicine at Glasgow, 4 - 8 September, 1994**