Ministry of Defence

Synopsis of Causation

Upper Limb Amputation

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1. Disclaimer

This synopsis has been completed by medical practitioners. It is based on a literature search at the standard of a textbook of medicine and generalist review articles. It is not intended to be a meta-analysis of the literature on the condition specified.

Every effort has been taken to ensure that the information contained in the synopsis is accurate and consistent with current knowledge and practice and to do this the synopsis has been subject to an external validation process by consultants in a relevant specialty nominated by the Royal Society of Medicine.

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1. Definition

1.1. Amputation is a surgical procedure for removal of part or the whole of a limb. Upper limb amputation involves removal of all or part of the fingers, hand, forearm, upper arm or shoulder. Different types of amputation in the upper limb are forequarter (2%), shoulder disarticulation (5%), trans-humeral (28%), elbow disarticulation (0.3%), trans-radial (19%), wrist disarticulation (2%), partial hand (19%) and digit (22%).[1] The most common causes of upper limb absence are heredity, conditions at birth (congenital) or surgical removal for traumatic, malignant or vascular reasons. Compared to lower limb amputation, upper limb deficiency is often relatively more functionally disabling due to the fine motor tasks carried out by the hand and arm. Human beings adapt very well however and the contralateral upper limb takes over most of the tasks and becomes the dominant limb. The level of amputation will largely determine the degree of functional disability i.e. the impact on quality of life and the ability to carry out tasks of daily living.

2. Aetiology

2.1. The reasons for amputation vary between the upper and lower limbs. The upper limb accounts for only 3-15% of all amputations and is uncommon.[2] The major reasons for amputation in the upper limb are trauma (43%), congenital absence (18%), and cancer (14%).[1] Exact figures on the incidence of upper limb amputations during conflict is not available.[3]

2.2. **Trauma.**

2.2.1. Both the civilian and the military population are exposed to circumstances in which crush injuries to limbs can occur, and both populations have an identical risk of sustaining those injuries. Another common mechanism of injury is as a result of road traffic accidents, and again both military and civilians are at similar risk. Crush injuries can be associated with substantial damage to the soft tissues surrounding the bones. In recent years Health and Safety regulations in the workplace have become more stringent and a subsequent decline in this type of trauma has been reported.[4]

2.2.2. War injuries, as seen in the Armed Services, frequently result in extensive soft tissue damage, in some cases without gross injury to the skin. These high-energy wounds can be produced by anti-personnel mines and high-velocity missiles, which cause a high degree of contamination of the wound with shrapnel as well as dirt. People handling explosives are more likely to sustain upper limb injuries, facial and eye injuries.[5] Both the extensive damage and the contamination complicate the treatment of these wounds. At present there are at least 75 countries in the world where significant minefields with anti-personnel devices have been laid. These minefields are producing large amounts of civilian casualties (15,000 to 20,000 per year in 2004), often in the poorest countries around the world.[6]

2.2.3. The severity of the injury involving the bones, muscles, nerves and blood vessels of a limb will determine the chances of successful repair. In those cases where the bones are exposed to the outside environment, and where blood vessels and nerves are severely damaged, the surgeon may have no option but to amputate part of the limb.

2.2.4. Frostbite is another common cause for upper limb amputation, especially of the fingers. Frostbite refers to the clinical situation where water molecules freeze and crystallise within biological tissue, resulting in the death of cells and tissue. The Synopsis *Cold Injury* considers the topic in more detail. A debridement will be carried out and an attempt will be made to cover tissue defects with skin grafts. If deeper structures such as bone are involved amputation might be required.

2.3. **Limb deficiencies at birth.**

2.3.1. There are numerous congenital conditions in which newborns exhibit limb deficiencies of varying severity. In most children the cause of limb deficiency is not known. Other causes are generally categorised as:

- Genetic (inherited).
- Vascular (related to blood supply).
- Related to problems during pregnancy.

2.4. **Cancer.**

2.4.1. Malignant tumours of the bones and soft tissues, such as osteosarcoma, chondrosarcoma and Ewing's sarcoma, are relatively rare cancers. In all they only represent approximately 1% of all cancers diagnosed in the UK; about 2,000 cases a year.[7] In contrast to many other types of cancer, bone and soft tissue cancers have a relatively high prevalence among the younger age groups (20-40 year olds). In some cases surgical resection in the form of amputation is indicated. However, patients will often be treated with a combination of chemotherapy, radiotherapy and surgery. Shoulder and forequarter amputations (amputations at the level of or including the shoulder joint) are the most common procedures performed.

3. Treatment

3.1. **Surgery.**

3.1.1. The timing of surgical procedures is especially important in war injuries. When timely evacuation from a war zone occurs, the rate of complications can be kept to a minimum. Many such injuries are often heavily contaminated and the primary treatment should be carried out as soon as possible. Thorough debridement and antibiotics are essential in the effort to prevent the common problem of infection, which complicates any contaminated wound. A general surgeon who has access to a simple theatre with basic aseptic facilities can easily carry out this initial treatment. The definitive limb amputation will usually be carried out by the orthopaedic surgeon and in trauma cases this is often performed in conjunction with the plastic/reconstructive surgeon in order to obtain healthy soft tissue coverage of the wound.

3.1.2. After a relatively short stay in hospital the amputee will start a prolonged period of rehabilitation. The aims of rehabilitation are to reduce swelling, prevent contractures, increase strength, assist with adjustment to the loss of a body part and maximise functional independence. This period is characterised by the need to attend many clinics and outpatient sessions in different specialties.

3.1.3. **Microsurgery.** There have been many advances in the management of trauma patients in the last 10 years. Surgeons nowadays have various (micro) surgical techniques in their armamentarium, which potentially can save very severely injured limbs.

3.1.4. **Re-implantation.** Using those microsurgical techniques has made re-attachment of completely severed limbs possible in some cases. This depends on many factors such as the extent of tissue loss, time from traumatic amputation, local surgical facilities and expertise.

3.1.5. **Limb transplantation.** The transplantation of a limb of another person was first carried out in the 1960s. Since then the development of drugs that prevent rejection of the transplanted limb by the host (the amputee) has progressed rapidly. The toxicity of those drugs, a limited success rate and shortage of suitable donors mean that this technique is not widely available at present.

3.1.6. **Osseointegration** is a technique in which an anchor for a prosthetic device is directly placed in bone; skin is then left to grow around the anchor. This technique has been adopted with varying success, and

further research into the prevention of loosening and infection of the implant is needed.

3.2. **Multi-disciplinary Approach.**

3.2.1. A multi-disciplinary group of health care professionals aims to rehabilitate amputees to their maximum level of independence. The team consists of an orthopaedic/plastic surgery/rehabilitation consultant, prosthetist, occupational therapist (OT), physiotherapist (PT) and a community paediatrician (if a child is involved). The OT is one of the most important members of this team and much time is spent with this specialist. The OT will assess the needs of the amputee with regards to the activities of daily living, such as dressing, toilet care, cooking etc. Besides this the OT will review the amputee's home situation and advise on any changes that are likely to be needed. The OT also plays an important part in the rehabilitation of occupational and recreational activities of the amputee.

3.3. **Artificial Limb (Prosthesis).**

3.3.1. Prosthetic fitting occurs shortly after the operation and as soon as the wound is healed. Many amputees prefer to be fitted with a cosmetic limb prosthesis, which has little functional benefit; others might not have any prosthesis fitted. The latter is frequently the case in children born with a deficiency, as their other limb(s) will take over the function of their missing limb.

3.3.2. Upper limb amputees may be fitted with body powered or in some cases myoelectric prostheses. Myoelectric prostheses make use of the residual muscles to activate a switch in the prosthesis, whereas body powered devices are controlled by upper body movements via cables and straps.

3.3.3. Developments and research into limb prosthetics are motivated by the attempt to recreate a physiologically functioning limb. Many different types of prosthesis are being developed; these are increasingly sophisticated and make use of the latest computer technology. Generally, the longer the remaining stump the easier it is to fit a functioning prosthesis.

4. Prognosis

4.1. **Stump**. The stump will be bandaged and sometimes splinted with a cast for the first 2 to 3 weeks after the amputation. Occasionally complications of surgery occur such as: delayed wound healing, infection, limb fitting problems, joint contractures, impaired control of the limb, painful scars or stumps. These problems are frequently due to the circumstances in which the limb was amputated. Each member of the rehabilitation team will try to identify problems early and manage them appropriately. A commonly seen problem is stump pain which, in upper limb amputees, is reported to be as high as 49%. This has been shown to have a high correlation with the existence of phantom pain, see section 4.4.[8] The onset of stump pain can be immediately post-surgery, as the result of early complications, or delayed due to poor stump hygiene, a poorly fitting prosthesis, chronic infection or part of a chronic pain syndrome. Usually a direct cause for the pain can be identified and corrected. Occasionally the pain will prevent amputees from using a prosthesis or artificial limb.

4.2. **Immediate complications of surgery.**

4.2.1. **Infection** is the main complication of surgery that must be prevented. Infection rates are higher in traumatic or war injuries and vary widely depending on the facilities available in the field. Timing of surgery, aseptic technique, appropriate level of amputation and achieving adequate soft tissue cover are also important factors. The appropriate antibiotics must be chosen in the case of a suspected infection. If the infection cannot be controlled with antibiotics further surgery might be needed to release any infection around the stump. Bone infections often require additional surgery resulting in further resection of bone with shortening of the stump as a consequence. This can lead to added functional loss of the limb.

4.2.2. **Haematoma formation** after the operation is prevented by meticulous cauterisation of vessels during the procedure. A haematoma causes persistent pain post-operatively which only resolves after the stump is either aspirated or decompressed surgically in theatre. A haematoma increases the risk of infection as it acts as a potential growth medium for bacteria and may cause wound healing problems.

4.2.3. **Deep venous thrombosis** (clots in the veins of a limb) is an uncommon post-operative problem as patients with upper limb amputations can mobilise more easily than those with lower limb amputations.

4.2.4. The occurrence of these complications theoretically increases the risk of developing chronic pain syndromes although a direct connection has not been proven. The circumstances that precipitate chronic pain syndromes are poorly understood and further research into these phenomena is required.

4.3. **Stump lengthening.** Occasionally amputees have a very short stump, which is unsuitable for any prosthesis. In those cases the surgeon may be able to perform a limb lengthening procedure using an external fixator. This is a device consisting of pins or wires, which are positioned in the bone and then fixed to scaffolding outside the body. The bone in the stump is broken and slowly distracted during the time the bone takes to heal. In this way the bone is slowly lengthened and made suitable for a prosthesis.

4.4. **Phantom limb phenomenon.** (sensation and pain). Immediately after amputation many patients feel that their amputated limb is still present and moving. Prevalence of this phenomenon has been reported as high as 76%.[8,9] The sensation will usually gradually disappear, but in some cases will persist for years after the amputation. For most amputees this is not a serious problem. However if the amputee actually feels pain in the missing limb, called phantom pain, this can become a significant and potentially chronic issue. Experiencing phantom pain is a reasonably common phenomenon (prevalence is 49%); this is strongly associated with pain prior to the amputation.[8] Therefore, a high incidence of phantom pain can be expected in patients who have undergone an amputation for traumatic reasons. However, not many amputees will experience the phantom pain to such a degree that it influences their function. Despite much research, phantom limb pain remains poorly understood. Current thoughts on the subject suggest that it represents a chronic pain syndrome with psychological as well as physiological components. The level of amputation does not seem to influence the occurrence of phantom pain.[8]

4.5. **Losing a limb**. The physical and psychological impact of the sudden loss of a limb is considerable, especially in a previously fit person. Amputation can be regarded as a triple loss: loss of function, loss of sensation and loss of body image. Patients' reactions vary greatly depending on age, personality, coping ability, vocation, social support, previous health and the reason for amputation. Some patients will experience a degree of depression, which is a natural reaction to the loss of a limb. No relation between depression and phantom limb pain has been identified, however.[10] Rehabilitation staff will be able to help with this and amputees are encouraged to discuss these matters. Many adapt very well given resilience, motivation and a positive attitude. Children born with congenital deficiencies generally cope very well and compensate for their deficiencies with their other limbs.

4.6. **Prognosis.** It is difficult to give an exact prognosis in upper limb amputations, as this will depend on the initial indication for amputation. If the patient underwent the procedure as the result of a chronic disease, which might deteriorate over time, further problems may be expected. In most trauma cases however, amputees would be rehabilitated to a certain level of functioning and no deterioration of their condition would be expected unless complications regarding the stump arose. Most rehabilitation programmes are focussed on achieving an amputee's independence both at home as well as at work. In total 73% of amputees will achieve a return to employment; many however, (67%) will have to change jobs. In upper limb amputation up to 50% of people will experience complaints relating to the contralateral limb. Amputees experience a higher degree of complaints relating to overuse in the remaining limb compared to the general population.[10] A third of upper limb amputees will reject their prosthesis and most will use it only for cosmesis; for this reason lightweight rather than body-powered prostheses are preferred. Rehabilitation programmes should focus on both prosthetic and nonprosthetic training to achieve maximum independence.

5. Summary

5.1. Upper limb amputation, as the result of trauma, disease or congenital malformation, is a problem that will lead to a certain level of functional disability. The rehabilitation process can be fraught with difficulties, both physical and emotional. Most amputees do very well given resolve, motivation, perseverance and the aid of a large multidisciplinary team.

6. Related Synopses

Lower Limb Amputation.

7. Glossary

aseptic	Antiseptic, avoiding sepsis (infectious contamination).
congenital	A trait present at birth whether inherited or not.
contracture	A permanent tightening of muscle, tendons, ligaments or skin around a joint, resulting in reduced movement of that joint.
contralateral	The opposite limb/side.
debridement	Surgical term meaning thorough removal of all contaminants and dead tissue in a wound.
genetic	Relating to human genes.
haematoma	A blood clot that lies between the soft tissues.
humeral	Relating to the humerus (upper arm bone).
malignant	Cancerous, relating to cancer.
microsurgery	Surgery using a microscope in order to operate on the smallest blood vessels and nerves.
myoelectric	Sophisticated electronic system whereby small electric muscle/nerve impulses are translated into an electric signal.
osseointegration	A direct rigid connection between living bone and the surface of a load-carrying implant.
physiological	Relating to the bodily functioning of a human being.
prosthesis	A device, such as an artificial leg, that replaces a part of the body.
radial	Relating to the radius (one of the two forearm bones).

re-implantation	Surgery performed to reattach an almost completely amputated limb following trauma.
rejection	The rejection of a transplanted limb/organ by the recipient's immune system.
soft tissues	Structures including skin, muscles, tendons, ligaments, blood vessels and nerves.
toxicity	The extent, quality or degree of being poisonous.
transplantation	The replacement of structures with tissue from the person's own body or from another person.
traumatic	Relating to injury.
vascular	Relating to blood vessels i.e. both arteries and veins.

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