

ОГЛЯД ЛІТЕРАТУРИ

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**CURRENT STATUS OF CAUSES OF AMPUTATIONS IN
MILITARY SERVANTS**

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Abstract. Today, amputations are performed taking into account all the principles of minimally invasiveness, hemostasis and subsequent rehabilitation. The war in Ukraine has brought the problem of amputations to the level of a humanitarian catastrophe. However, a rehabilitation response system is also being developed in parallel.

Amputation is considered not only as a medical intervention, but also as a complex biopsychosocial process that requires comprehensive rehabilitation. This is a complex physical, psychological and social challenge that requires a holistic, multidisciplinary approach.

The purpose of this study was to conduct a literature analysis of the reasons that occur during limb amputation in military personnel, under martial law in Ukraine, aimed at increasing the effectiveness of prosthetics and reducing recovery times.

The main cause of amputations among military personnel is mine-explosive trauma, which is accompanied not only by tissue destruction, but also by contamination of the wound with fragments of soil, clothing, and metal. Such injuries are often combined - with damage to soft tissues, blood vessels, bones, which significantly reduces the chances of saving the limb.

Another common cause is high-energy gunshot wounds, accompanied by destruction of muscles, bones and blood vessels. In case of gunshot injury to the limb with damage to the main arteries, there is a risk of ischemia, and with delayed revascularization - irreversible changes in the tissues that require amputation.

Modern approaches to amputations in conditions of full-scale war have undergone significant changes. The main paradigm has shifted from simple «saving life» to maximum preservation of functionality for future prosthetics.

Conclusions. 1. Modern military medicine has turned amputation into a complex plastic and neurosurgical manipulation. The main goal of which is not just survival, but the return of a person to an active life, sports and even military service using modern technologies.

2. In today's world, amputation is not considered simply the removal of a body segment. It is the first stage of creating a new organ - the «stump + prosthesis» system. The surgeon on the operating table must complete the operation and think like a prosthetist, preparing for the future for the mandatory possibility of prosthetics.

3. The priority is to preserve the length of the bone as much as possible, even if this requires complex plastic surgery. A longer stump means less energy consumption for the patient when walking and better stabilization.

4. The use of regional anesthesia and proper work with nerve trunks during surgery reduces phantom pain, which critically affects the mental health of the serviceman in the future.

5. The success of rehabilitation now depends on a multidisciplinary team, where the surgeon, anesthesiologist, physical therapist and prosthetist work in a single protocol and are as close as possible to each other.

Keywords: surgery, war, limb amputation, limb stump formation, mine-blast injury, servicemen with lower limb amputations, phantom pain, level of amputation.

Introduction. Historical development of amputation: from survival to medical strategy. Performed in prehistoric times, archaeologists have found bones with signs of healed amputation since the Neolithic era [1]. In ancient Egypt and India, cases of amputation are known, associated with both medical and ritual reasons [1]. In Greece and Rome, surgeons, mainly military, used amputation to

save the lives of the wounded in battle, although the high mortality rate due to infections limited the effectiveness of the procedure [1]. The turning point was the era of the 18th–19th centuries. During the Napoleonic Wars, the French surgeon Dominique Jean Larrey initiated the practice of field surgery, operating on the wounded directly on the battlefield. This allowed to significantly reduce mortal-

ity and shorten the time to intervention [16, 17]. The 20th century brought the use of antiseptics, anesthesia and the beginning of the era of modern prosthetics.

Today, amputations are performed with all the principles of minimal invasiveness, hemostasis and subsequent rehabilitation in mind. According to data, up to 80% of patients after amputation suffer from phantom pain - a painful sensation in the no longer existing limb, caused by neuroplastic changes in the central nervous system [5].

Psychological trauma: the body as part of the self. Amputation is not only a physical loss, but also a deep psychological trauma that affects the body, psyche and social identity of a person [22]. In clinical psychology, it is considered an existential crisis, which leads to a long period of adaptation. According to the model of experiencing loss by Elisabeth Kubler-Ross, patients go through the stages of denial, anger, bargaining, depression and acceptance [6]. However, not everyone goes through this path sequentially. Often, patients get stuck in a phase of depression or social alienation, especially in conditions of insufficient support. Studies by the National Center "Indestructible" show that more than 60% of patients after amputations need psychological help, but only a third turn to specialists [7]. Reasons: shame, fear of admitting the problem, distrust or lack of access to qualified psychotherapy. In his phenomenology, the philosopher Maurice Merleau-Ponty described the body as a "center of consciousness" — not just a mechanism, but a way of interacting with the world around us [4]. The loss of a body part questions the usual identity, changes the experience of perceiving reality. For many amputees, this loss becomes an impulse to form a new identity, in which new life meanings appear: through overcoming pain, through helping others, through realization in sports, social initiatives or creativity [23]. This problem has become particularly acute and relevant in the conditions of the ongoing martial law in Ukraine. Armed aggression has led to a significant increase in the number of people with mine-explosive and other combat injuries, which often end in limb amputations. According to data as of the end of 2024, an impressive number of amputations were registered in Ukraine - 29,574 cases, among which the vast majority (over 24 thousand) are lower limb amputations, 3.9 thousand are upper limb amputations, and another 1.5 thousand are other types of amputations [8]. These statistics clearly demonstrate the scale of the problem and the urgent need to develop an effective and comprehensive rehabilitation system, where high-quality preparation of the stump for prosthetics is one of the key elements.

The war in Ukraine has brought the problem of amputations to the level of a humanitarian disaster. However, a rehabilitation response system is also being developed in parallel.

The rationale for the research is to analyze the causes of amputations in military personnel and the impact on the formation of limb stumps for prosthetics.

The aim of this research was to conduct a literature analysis of the reasons that occur during limb amputation in military personnel, under martial law in Ukraine, aimed

at increasing the effectiveness of prosthetics and reducing recovery times.

Results and discussion. Amputation is considered not only as a medical intervention, but also as a complex biopsychosocial process that requires comprehensive rehabilitation [18, 29]. It is a complex physical, psychological and social challenge that requires a holistic, multidisciplinary approach. This experience poses difficult questions about the body, identity and meaning of life. At the same time, it opens up opportunities for a new start, the formation of a new self, based not only on physical functions, but also on dignity, strength of spirit and hope. For specialists, this means the need to constantly update their knowledge, implement advanced rehabilitation methods and adapt to changes. Mastering modern technologies, sharing experience with colleagues from all over the world, and responding quickly to new challenges are becoming indispensable skills. However, it is no less important to remain not only a highly qualified specialist, but also a sensitive companion for the patient on his journey from pain to recovery.

A true professional is someone who is able to see behind the wound not just a problem, but, above all, a person.

When analyzing domestic and foreign literature, several causes of limb amputations were formed.

Amputation, as a consequence of trauma. Amputation is a surgical intervention that results in partial or complete removal of a limb [1]. Although such an operation is a last resort, it is often the only opportunity to save the patient's life in cases of severe tissue damage, gangrene, necrosis, ischemia, oncological lesions, or serious injuries [9]. This procedure has become particularly relevant in the context of a full-scale war in Ukraine, where mine and explosive injuries, shrapnel and gunshot wounds have become a tragic everyday occurrence [2, 13]. According to the Ministry of Health of Ukraine and the National Rehabilitation Center "Nezlamny", as of the beginning of 2024, more than 62,000 Ukrainians have suffered amputations as a result of hostilities [3]. Among them are both military and civilians, including children. The injuries are often so serious that saving the limb is impossible without a threat to life, so amputation becomes a forced decision. Amputation is not limited to physical intervention. It is a phenomenon that causes profound consequences at the psychological, social and even philosophical levels. It transforms not only the appearance of the body, but also changes a person's perception of their own identity, their capabilities and their role in society and the world at large [4, 22, 23].

Amputation is one of the most radical surgical interventions, which is performed to save the patient's life in cases of severe injuries, uncontrolled infections, ischemia or polystructural injuries. In peacetime, the main causes of amputations include diabetes mellitus, chronic ischemia of the lower extremities, oncological diseases of the musculoskeletal system and the consequences of advanced infections [9]. However, in the context of armed conflict, especially during intense hostilities, the structure of the causes of amputations undergoes significant changes [10, 13].

The main cause of amputations among military personnel is mine-explosive trauma, which is accompanied

not only by tissue destruction, but also by contamination of the wound with fragments of soil, clothing, and metal. Such injuries are often combined - with damage to soft tissues, blood vessels, bones, which significantly reduces the chances of saving the limb [2, 10, 13].

According to studies by American military surgeons, more than 80% of amputations in the military in Iraq and Afghanistan were caused by explosive devices [10]. A similar situation is observed during the Russian-Ukrainian war. Servicemen of the Armed Forces of Ukraine most often lose limbs due to mine explosions, artillery shelling, and kamikaze drone strikes [12].

Another common cause is high-energy gunshot wounds, which are accompanied by destruction of muscles, bones, and blood vessels [11]. In case of gunshot trauma to the limb with damage to the main arteries, there is a risk of ischemia, and if revascularization is delayed, irreversible tissue changes occur that require amputation [11].

It is also worth considering that on the battlefield it is often impossible to provide full vascular care in the first «golden hours», so even potentially saved limbs are subject to amputation due to late diagnosis of ischemia or the development of gangrene.

Septic and infectious complications. Many amputations do not occur immediately after injury, but as a secondary intervention when the affected area becomes infected. Purulent-septic complications are very common in war conditions, where wounds are often received in an antiseptically non-sterile environment - trenches, trenches, ruins of buildings. In addition, contamination of wounds with bacteria, including multi-resistant strains, reduces the effectiveness of conservative treatment [14].

If antibacterial therapy is ineffective or necrotizing fasciitis develops, surgeons are forced to resort to amputation as the only option to save the patient's life.

Special attention deserves the group of patients in whom amputation is performed due to complete or partial traumatic avulsion of the limb. Such injuries are usually almost impossible to restore, especially if the stump is significantly damaged and the time that has passed since the injury exceeds the limits permissible for successful replantation.

In addition, there is an increase in the number of amputations for prophylactic purposes. In such cases, with deep necrosis or irreversible tissue damage, amputation is performed to prevent the development of systemic intoxication or sepsis.

The use of tourniquets in modern tactical medicine significantly reduces the mortality rate on the battlefield, but at the same time can lead to the risk of ischemic lesions. Prolonged application of a tourniquet to a limb for more than 2 hours significantly increases the likelihood of ischemic necrosis, especially in conditions of low temperatures.

Thus, a tourniquet is an effective means of saving lives, but can complicate the preservation of the limb in the long term. In a number of cases, patients who managed to stop the bleeding in a timely manner still have to undergo

amputation in the future.

In summary, the main causes of amputations in military personnel can be identified:

- mine-explosive injuries with significant tissue damage;
- gunshot wounds accompanied by damage to the neurovascular bundle;
- tissue ischemia, including post-tourniquet ischemia;
- purulent-necrotic complications, such as gangrene, abscesses, osteomyelitis;
- traumatic amputations of limbs that are not amenable to reimplantation.

In practice, these factors are often combined, which significantly complicates the choice of treatment tactics. In such cases, amputation becomes not just a surgical intervention, but a complex ethical and clinical decision aimed at preserving life and preventing the development of multiple organ failure.

Modern approaches to amputations in conditions of full-scale war have undergone significant changes. The main paradigm has shifted from simple «saving life» to maximum preservation of functionality for future prosthetics. Here, several aspects and approaches in modern military field surgery regarding amputations can be distinguished:

- the concept of «Damage Control Surgery» (DCS) [18].

In conditions of combat operations, amputation is often performed in several stages. In the first stage (on the front line), the priority is to stop the bleeding and fight the infection.

Guillotine amputation is used extremely rarely: It is practically not used in its pure form now. Instead, primary surgical treatment is used with the cutting off of non-viable tissues without the final formation of a stump.

Delayed closure: The stump is never sutured tightly in the first stage due to the high risk of anaerobic infection and edema.

- preservation of length and «injury zone».

Previously, there were strict «levels of choice» (for example, upper, middle, lower third of the tibia). Today, the approach is individual: we fight for every centimeter of bone and soft tissue. Lever length: The longer the stump, the easier it is for the patient to control the prosthesis. Tissue replantation: The use of skin flaps from the parts of the limb to be removed to close the wound (the so-called «spare parts surgery»).

- reconstructive techniques during amputation.

Modern surgery integrates elements of rehabilitation directly into the operation: - Myodesis and myoplasty: Fixation of muscles to the bone or to each other prevents atrophy and allows the patient to «feel» the phantom limb, which is critical for bionic prostheses.

- Targeted Muscle Reinnervation (TMR): Redirecting severed nerves to other muscles [24–29]. This radically reduces phantom pain and in the future allows high-tech prostheses to be controlled using intuitive brain signals.

- Prevention of phantom pain.

Pain is the main enemy of rehabilitation. The modern

approach includes:

Regional anesthesia: Installation of catheters for long-term administration of anesthetics directly into the nerve trunks.

Surgical treatment of nerves: The nerves are cut with a sharp blade under tension so that they hide deep in the tissues, preventing the formation of painful neuromas.

- **Osseointegration**, this is one of the promising areas. For patients with very short stumps, where a conventional prosthesis does not hold, osseointegration is used - the implantation of a metal implant directly into the bone, to which the prosthesis is then attached.

Conclusions. 1. Modern military medicine has turned amputation into a complex plastic and neurosurgical manipulation. The main goal of which is not just survival, but the return of a person to an active life, sports and even military service using modern technologies.

2. In today's world, amputation is not considered simply the removal of a body segment. This is the first stage of creating a new organ - the «stump + prosthesis» system. The surgeon on the operating table must complete the operation and think like a prosthetist, preparing for the future the mandatory possibility of prosthetics.

3. The priority is to preserve the length of the bone as much as possible, even if this requires complex plastic surgery. A longer stump means less energy consumption

for the patient when walking and better stabilization.

4. The use of regional anesthesia and proper work with nerve trunks during surgery reduces phantom pain, which critically affects the mental health of a serviceman in the future.

5. The success of rehabilitation now depends on a multidisciplinary team, where the surgeon, anesthesiologist, physical therapist, and prosthetist work in a single protocol and are as close to each other as possible.

Prospects for further research. Our research is aimed at finding the existing causes of limb amputations and preventing their further decline.

Conflict of interest. The authors declare that they have no conflict of interest in relation to this study, including financial, personal, authorship, or any other conflict that could affect the research and its results presented in this article.

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All authors have read and agreed with the published version of the manuscript.

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СУЧАСНИЙ СТАН І ПРИЧИНИ АМПУТАЦІЙ У ВІЙСЬКОВОСЛУЖБОВЦІВ

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Резюме. Сьогодні ампутації виконуються з урахуванням усіх принципів малоінвазивності, гемостазу та подальшої реабілітації. Війна в Україні вивела проблему ампутацій на рівень гуманітарної катастрофи. Проте паралельно розгортається і система реабілітаційної відповіді.

Ампутація розглядається не лише як медичне втручання, але й як складний біопсихосоціальний процес, що потребує комплексної реабілітації. Це складний фізичний, психологічний і соціальний виклик, який вимагає цілісного, мультидисциплінарного підходу.

Метою дослідження є аналіз літературних даних щодо причин ампутації кінцівок у військовослужбовців в умовах воєнного стану в Україні для підвищення ефективності протезування та скорочення термінів реабілітації.

Головною причиною ампутацій серед військовослужбовців є мінно-вибухова травма, що супроводжується не лише руйнуванням тканин, але й забрудненням рани фрагментами ґрунту, одягу, металу. Такі ушкодження часто є комбінованими, із ураженням м'язів, судин, кісток, що значно зменшує шанси на збереження кінцівки.

Ще однією поширеною причиною ампутацій є високоенергетичні вогнепальні поранення, які супроводжуються руйнуванням м'язів, кісток і судин. У разі пошкодження магістральних артерій виникає високий ризик ішемії, а затримка ревазуляризації призводить до незворотних змін у тканинах, що потребують ампутації.

Сучасні підходи до ампутацій в умовах повномасштабної війни зазнали значних змін. Головна парадигма змістилася від простого «рятування життя» до максимального збереження функціональності для майбутнього протезування.

Висновок. 1. Сучасна військова медицина перетворила ампутацію на складну пластичну та нейрохірургічну маніпуляцію. Головна мета якої не просто виживання, а повернення людини до активного життя, спорту та навіть до військової служби з використанням сучасних технологій.

2. У світі сьогоднішніх реалій ампутація не розглядається як просто видалення сегмента тіла. Це перший етап створення нового органу — системи «кукса + протез». Під час виконання ампутації хірург повинен мислити

як протезист, заздалегідь створюючи оптимальні умови для подальшого протезування.

3. Пріоритетним напрямком є максимальне збереження довжини кістки, навіть якщо це потребує складних пластичних операцій. Оскільки, чим довша кукса, тим менші енерговитрати пацієнта при ходьбі та краща стабілізація.

4. Використання регіонарної анестезії та правильна робота з нервовими стовбурами під час операції зменшує фантомні болі, що є критично важливим, тому що безпосередньо впливає на ментальне здоров'я військовослужбовця в майбутньому.

5. Успіх реабілітації сьогодні залежить від мультидисциплінарної команди, у якій хірург, анестезіолог, фізичний терапевт і протезист працюють за єдиним протоколом та у тісній взаємодії.

Ключові слова: хірургія, війна, ампутація кінцівки, формування кукси кінцівки, мінно-вибухова травма, військовослужбовці з ампутаціями нижніх кінцівок, фантомний біль, рівень ампутації.

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