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Postoperative psychological and social rehabilitation of patients with limb amputations

*Adrian Silaghi [1], Ioana Paunica [2], Daniela Gabriela Balan [3], Bogdan Socea [1, 4], Ion G. Motofei [1,4 *], Constantin Vlad Denis [1 ,4]*

Abstract

Mental health can be negatively affected during life to varying degrees, from minor indispositions created by daily debates, to major psycho-social traumas that have a significant and long-term impact. Physical injuries, especially those involving limb amputation, are probably the most traumatic and hard to accept events, as they cause severe biological, psychological and social damage to the individual. Losing a limb or part of a limb leads to significant physical disability, changes in physical appearance and self-esteem, difficulty returning to work and problems with social integration. Consequently, after an amputation operation, the patient's recovery must be approached with great care. Some of the patients adapt relatively easily to the new condition, while others successfully benefit from intensive recovery programs. Unfortunately, a small group of patients fail in post-operative recovery and some even believe that isolation/suicide could be a possible solution for their difficulties.

The psychological response/behavior of patients to limb amputations is dependent on many factors, such as: personality, level of education, social status, the environment and culture from which it originates, the support from society in terms of their integration, age, gender, the affected limb and extent of amputation, accessibility to different methods of recovery/prosthetics, etc. This complexity of the factors involved in the post-operative recovery period of the amputee patient causes the rehabilitation programs to be extremely elaborate on the one hand, but also highly personalized according to the individual characteristics, on the other hand. In this review, aspects of the psychological rehabilitation of patients undergoing limb amputation are presented and updated. It seems that such measures should be approached interdisciplinary with the patient and initiated even before surgery, if possible, to achieve the best possible results.

[1] St. Pantelimon Emergency Clinical Hospital, Department of General Surgery, Bucharest, Romania

[2] Carol Davila University of Medicine and Pharmacy, Doctoral School, Bucharest, Romania

[3] Carol Davila University of Medicine and Pharmacy, Department of Physiology, Bucharest, Romania,

[4] Carol Davila University of Medicine and Pharmacy, Department of General Surgery, Bucharest, Romania

E-mail corresponding author: igmotofei@yahoo.com

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1. Introduction

Amputations represent the removal of a limb (entirely, or only a part) with the aim of maintaining the health/functionality of the limb or, in exceptional cases, to save the individual's life. From a surgical point of view, amputation operations can be performed electively (with the aim of removing a possible malignant pathology) or in emergency mode (for post-traumatic amputations, or severe infections that can no longer be controlled by conservative or minimally invasive methods, etc.) (Atherton & Robertson, 2006).

At the level of the lower limbs, amputations are divided by the tibiotarsal joint into major/proximal amputations (trans-tibial, trans-femoral, hemipelvectomy, etc.) and minor amputations (finger amputations, radius amputations, etc.) (Keeves et al., 2022). For the upper limb, the radiocarpal joint represents the limit, dividing them into minor (finger, trans-phalangeal or trans-carpal) amputations and major (trans-radial, transhumeral disarticulation of the shoulder and interscapular-thoracic) amputations (Schober & Abrahamsen, 2022).

Upper and lower limbs play a vital role in our daily activities. Through them and with the contribution of our senses, we begin to perceive and explore the world around us from an early age, so that the lesions of these vital structures have a major impact both on the formation and on the well-being of the individual (Aslam et al., 2022; Orrù et al., 2020). Depending on the individual, the impact on the cognitive and emotional system given by the loss of a limb is comparable to the premature loss of a life partner, with a symbolic castration or even death (Block & Ventur, 1963; Grisales et al, 2022; Marzen-Groller et al., 2008; Marchini et al., 2021; Parkes, 1972). Thus, patients may develop varying degrees of postoperative depression and a marked decrease in quality of life, according to psychological conditions due to medical conditions and treatments (Barchetta et al., 2021; Bellani et al., 2008; Caputo et al., 2022; Formica et al., 2022; Martino et al., 2021; Myles et al., 2022; Myles & Merlo, 2022a, 2022b; Pedras et al., 2018, 2020; Pennisi et al., 2022; Sarwer & Crerand, 2002; Vicario et al., 2020; Vita et al., 2020).

These are caused both by the changes imposed by the mutilating intervention, and by the possible complications that may occur (such as chronic pain, the appearance of the phantom limb, or infectious complications that require long surgical or medical treatments, etc.) (Durmus et al., 2015). Generally, the psychological consequence resulting from the amputation of the limb can be compared with symptoms similar to post-traumatic stress disorder (especially if the amputation was necessary as a result of a car accident, explosions or other sudden events),

because the patient does not have time to develop individual coping mechanisms (Abeyasinghe et al., 2012; Cavanagh et al, 2006).

The general principles of an amputation are similar regardless of location (placed at the level of the upper or lower extremity) or etiopathogenesis (traumatic pathology or in the context of a neoplastic condition). When possible, vascular injuries should be treated by reconstructive interventions, which should be as physiological as possible for the residual limb, that is, the healing result should be as close to normal as possible. When the reconstructive intervention does not lead to a good recovery, the remaining limb must still have good sensory capacity such as thermal sensation, proprioceptive sensation and an adequate ability to feel pain in a way similar to that of a healthy limb; also, motor function must be preserved as much as possible. The second rule of amputation that must be respected refers to the lack of tension in the structures that cover the remaining bone. The integument and the muscle layer that covers the bone tissue must not be in tension, which can lead to good mobility and local vascularization. By following this rule, it is necessary that the scar be placed on a surface without tension, not exposed to pressure, and with an adequate supply of blood (Karslioglu, 2021).

Amputations are present in all age groups, from infants (in terms of malformative pathology) to the elderly (who may have multiple vascular and metabolic comorbidities). Thus, in the pediatric population and young patients, a frequent cause is traumatic pathology, followed by neoplastic disease. In the elderly, vascular disease is the most common etiology of amputation (acute peripheral arterial ischemia, deep venous thrombosis, chronic venous insufficiency), associated or not with the presence of elevated blood glucose levels (diabetes mellitus) (Letton & Chwals, 1994; Ziegler-Graham et al., 2008).

The purpose of this study is to investigate the impact of different types of amputations on the quality of life and on the mental state of the patients, depending on the etiology of the amputation, the limb involved, the age group, as well as to identify factors able to influence the positive evolution of patients after amputations of the limbs.

2. State of the art

2.1 Epidemiology

People requiring limb amputation vary according to age, environmental factors, residence factors, education level, social status, with clear differences between developed and underdeveloped regions regarding the etiology and prevalence of amputations in the population (Ziegler-Graham et al., 2008). There were 1.2 million amputees in the US in 1996 (Adams et al,

1999) with an increase of 400,000 in 2006 (Ziegler-Graham et al., 2008) 45% of these having a trauma-related amputation. Two-thirds of these patients were under 45 years of age (Dillingham et al., 1998), which involves long and expensive treatment to achieve a good quality of life (Ziegler-Graham et al., 2008). Over 65 years amputation occurs in 64% of cases due to vascular diseases, a consequence of the fact that the rate of cardiovascular diseases and diabetes are increasing with age (Ekremoğlu et al., 2020). Considering the doubling of the number of patients with diabetes by 2030, it is estimated that the number of amputees will reach 3.6 million, a value more than double (Ziegler-Graham et al., 2008).

In terms of race, it appears that Hispanics and African Americans have a 2 to 3 times higher risk of amputation than the white population (Lavery et al., 1996, 1999; van Houtum & Lavery, 1997). This difference is the consequence of several factors, such as genetic characteristics, nutrition, access to primary and secondary prevention services, which is correlated with the degree of well-being. For example, there is a 1:250 ratio of amputations in the general white population and a 1:90 ratio in the non-white population (Ziegler-Graham et al., 2008).

There is heterogeneous data on the Asian continent, as social and cultural differences vary from region to region. In India for example, the data show an increased rate of amputations both in rural areas among the poor population in the working age group, secondary to car or railway accidents, but also of obsolete agricultural machinery and without advanced protective measures (Magnusson et al., 2019). Thus, in the rural population, 70.3% of all amputations were secondary to trauma, and the rest is represented by vascular diseases with the predominance of the 20-30 age group (Priyadharshan et al., 2022). In the urban population, there is a higher incidence in men and especially in those who have associated vascular diseases and diabetes, they represent 84% of patients. Traumas take second place with 7.4% of the total, while the rest of the amputations are secondary to a localized malignancy in the limbs, usually associated with localized infection (Unnikrishnan et al., 2017).

The health system developed in the European Union, together with the fairly consistent medical insurance and the specific social-medical culture seem to be quite effective in reducing the number of amputations in this region of the world. A statistic made in the EU15+ region, which includes the countries that joined the European Union between 1995 and 2004 (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom) along with Australia (Carinci et al., 2016), recorded a significant decrease in the number of amputations performed between 1990 and 2017 (Hughes et al., 2020). The incidence of amputations for both sexes was highest

in Australia at around 40 per 100,000 population compared to the Netherlands where the incidence remained at around 18 per 100,000 population. Half were performed as the final treatment of diabetes (Lim et al., 2006), somewhat at odds with older data related to peripheral arterial disease (a major factor in amputation in the Australian population, which was lower than in other countries but with high rates of morbidity and mortality) (Goodall et al., 2021). The explanations are represented by the variability of the population density, the long time they have to wait until they reach a specialist doctor, the long distances that have to be traveled, which makes the patients reach an advanced stage of the disease, when the only effective therapeutic resource remains resection the affected member (Goodall et al., 2021).

Another cause of amputations, especially of the upper limbs, is trauma related to firearms, car accidents or improper use of various industrial devices. In the geographical area described above and for the period 1990-2017 there were no conflicts, road and rail systems were efficient, while workers in the industrial environment were very well trained to handle industrial equipment (equipped with high-performance systems related to self-control and safety) (Goodall et al., 2021).

Limb loss may be the consequence of curative resection in neoplastic disease. In the US, malignant tumors of the bone system account for about 6% of all cancers in the population under 20 years of age. The main histopathological types for which amputations are indicated are osteosarcoma and Ewing's sarcoma, with predominant localization in the lower limbs (Hassa & Aliç, 2022). Osteosarcoma occurs secondary to the abnormal development of immature bone tissue, occurring mainly in men under 25 years of age (Motofei, 2022-a). The genetic factors involved in the etiology of osteosarcoma are represented by the RB1 mutation which also leads to retinoblastoma (Zhang et al., 2022), and which increases the risk of developing a form of bone cancer more than 500 times (Imbert-Bouteille et al., 2019). Li-Fraumeni syndrome is characterized by the alteration of the gene encoding the p. 53 protein, an inhibitor of tumor development, which can lead to a wide range of neoplastic entities such as: breast cancer, sarcomas, leukemias, etc. (Nees et al., 2022). Environmental factors can influence bone development, thus exposure to ionizing radiation administered accidentally or therapeutically can lead to the appearance of osteosarcoma, especially in Ewing Sarcoma patients whose treatment is based on radiotherapy (Duverge et al., 2022). Psychopathological phenomena dueto these conditions are well-known in literature (Di Giacomo et al., 2019a, 2019b; Ranieri et al., 2020).

2.2 Mental and behavior changes after limb amputation

Depression is the most common mental and behavioral change that can occur after a limb resection. After a relatively short period of time, patients may be in a bad mood, unwilling to speak or eat properly, and show little interest in using the prosthesis (Wang et al., 2022). In the long term, limb amputation is associated with increased levels of social vulnerability, reduced quality of life and greater mobility. Most studies of large groups of amputees have shown that all these changes vary with age, time since amputation, and segment/level of amputation (Ostler et al., 2022).

Another psychological change that can occur after the loss of a limb is represented by anxiety related to the new representation of the body. Being an intervention that changes body image and self-esteem, the result can scare the person, and in some cases never be accepted. It can occur in association with depression, a low quality of life and self-esteem (Beisheim-Ryan et al., 2021).

Social discomfort can occur quite frequently in the amputee patient. It is caused by the differences that this group of people presents compared to the general population, most of them being considered disabled, which generates a phenomenon of constant stigmatization and the impression of helplessness (Rierola-Fochs et al., 2021). Most of the time, people with amputations are treated differently from normal people, who may make some erroneous claims about the causes of the amputation or about their lifestyle, sometimes even considering the amputation and the presence of disabilities to be defining for them (Zar et al., 2022). Experimental studies showed that people who mimed amputation were excluded from the group compared to those who had real amputations compensated by prosthesis. If they were nevertheless integrated into a group, most of the time people helped them without needing them, thus considering them powerless in carrying out certain tasks (Myles et al., 2021). This exaggerated kindness is a feature of society to make normal people be kind and helpful to those in need, but in fact this is partly a psychological mechanism to reduce personal anxiety in the case of interacting with a disabled person (Rabaey et al., 2021). Age can also be related to anxiety and social discomfort. Elderly patients who have suffered amputations have major difficulties in participating in social and cultural activities (Ostler et al., 2022). In contrast, younger patients, although they may have fewer social interactions than before the traumatic event, show a certain degree of flexibility and adaptability in trying to keep these events at acceptable levels. Some of the patients try new things and activities, focusing on their educational interests, visiting new/different places than before or finding new hobbies (Merlo et al., 2020). After an

amputation operation, individuals try to change both their mental status and their physical/social functioning, in order to adapt to the new conditions. In a first stage the patient tends to feel vulnerable or even mutilated; with the passage of time, the patient usually gets used to the new condition, tries to rediscover himself and identify new mechanisms/tools to cope with daily tasks. Most of the time, patients realize that physical activity can no longer be performed as before, and they make efforts regarding mobility to regain it. In general, patients partially adapt, but usually compensate by learning to live with their altered/ new self (Ostler et al., 2022).

2.3 Factors that can influence the psychological state after amputation of a limb

A variety of psychological changes can occur after amputation, the most severe of which are depression, changes in self-perception, social and functional discomfort. There are 3 categories of factors that predispose to the appearance of these changes, such as: factors related to the surgical intervention itself, social factors and personality factors (Ostler et al., 2022).

The cause that led to the amputation can also influence the subsequent evolution of the patient. Post-traumatic amputation occurs most of the time suddenly in full health, most patients accepting with difficulty the need to perform it. Some of the patients, especially among those with vascular diseases, develop various feelings such as anger and hostility (Coskun et al., 2020).

The level of amputation is an extremely important factor in patient recovery. If the remaining post-amputation segment is considerable, the effort required to perform certain activities is usually less, the body image remaining approximately the same, while the prosthesis protocol is usually easier to perform (Ostler et al., 2022). For example, a patient who is amputated above the knee will have more difficulty in daily activities compared to one who is amputated at the level of the calf (Adiyeke & Karagoz, 2022). The higher the degree of disability, the more intense the symptomatology, with patients presenting a higher level of anxiety, social discomfort (Weinstein, 1985) and depression (Shukla et al., 1982). It is a consequence of the current resemblance to a premorbid state, which consequently causes a much more pronounced state of regret and/or phobia (Guémann et al., 2022).

Time is another factor that can influence mental state. With the passage of time since the amputation, it has been observed that the patient's mental state has generally evolved for the better, as the patient adapts to the present situation (Saetta et al., 2022). This fact is very well highlighted in the elderly population and in some young patients, while another category of young patients tends to worsen psychiatric symptoms with the passage of time (Durmayüksel et al., 2021; Russotto et al., 2022).

Amputation is a surgical intervention that significantly changes the body image. In general, patients tend to go through 3 phases (distinct but interrelated) over a period of more than 18 months. The first phase is the initial shock, completed with acceptance of the intervention. The second phase is represented by recovery, when patients tend to mask/hide their deficits. Finally, the last stage is the one in which the patients' new condition (including the aesthetic and functional consequences) is accepted and incorporated into their social life (Fuchs et al., 2022).

The presence of phantom limb pain is another factor that influences the mental and general state of the post-amputation patient. From a physiopathological point of view, phantom limb pain can occur as a result of complex changes (of transduction, transmission, perception and modulation) related to pain secondary to amputation. Even if the limb is removed, the cortex remains intact, meaning that it is able to send motor signals but without receiving the corresponding proprioceptive and somatosensory inputs. In this way, a conflict is generated between the signals coming from the affected limb and the efferent neuron, by not closing the reflex arc. Secondary to the interaction between interconnected brain areas and descending pathways, there is increased activity of the N-methyl D aspartate (NMDA) receptor, which causes an increase in pain as a result of inactivation of inhibitory pathways (Schley et al., 2007). Initially, the presence of phantom limb pain was considered to be a specific post-amputation psychiatric manifestation. It has been estimated that it would be more frequent in limbs that have a marked importance for the physical image of the individual, and the patient is not able to understand what has happened to him or to accept the transformations (Ding et al., 2022). Recent data show that phantom limb is not a sign of denial or psychological dysfunction, because even if patients have adapted very well to the traumatic situation, phantom limb pain can still occur several years after the traumatic event (Liu et al. 2022). Phantom limb pain can be associated with symptoms such as stress, anxiety and depression; however, the results of the studies are varied and sometimes even contradictory (Kuffler, 2018; Myles & Merlo, 2021). Regarding the general literature, there is an association between chronic pain and depression, which reinforces the idea of an association between depressive symptoms and chronic pain (Kızıltaş et al., 2022). In conclusion, phantom limb pain can be influenced by stress, anxiety and depression, as in the case of other forms/syndromes of chronic pain (Quinlan-Colwell, 2014).

Another factor related to the amputation and which can cause changes in the mental state is represented by the pain in the remaining abutment, associated with two consecutive unfavorable phenomena. The first consequence is the occurrence of depression (Ali et al., 2022) and the second is the influence of psychological well-being. Thus, poorer rehabilitation has been

observed in amputees when pain is present (Miller et al, 2001; Sheikh et al, 2019), being secondary to reduced mobility. This can lead to a restriction of individuals' daily activity and subsequently to depression, anxiety and most often frustration, with a direct correlation between depression and restriction (Williamson & Schulz, 1995). Thus, if a greater degree of pain-related disability is present, the number of hours of wearing the prosthesis is reduced and the degree of social interaction may be reduced (Kristjansdottir et al, 2020). The prosthesis for amputees has both a functional role, helping as much as possible to carry out certain activities, and an aesthetic role to bring back to the subconscious an image as close as possible to the initial state. If this is missing or cannot be restored at least partially, the degree of depression may increase (Ostler et al., 2022).

Among the socio-demographic factors that can influence the post-amputation syndrome, the most important identified were represented by age, gender and social support. In the literature, many studies have not found large differences in female/male amputees and psychological well-being (Jo et al., 2021). In general, men have been shown to have a better ability to manage the situation compared to women, who, on the other hand, are more prone to depression (Merlo et al., 2021).

Age is another factor influencing adjustment after amputation. In this situation, the advantage is for older age groups with reduced mobility, young people being more prone to depressive episodes secondary to decreased mobility, pain and inability to care (Ostler et al., 2022). The young population and especially teenagers are very conscious and concerned about their body image. They are more prone to marginalization and are more disturbed by the different way in which they are perceived by the collective, but no significant correlations were observed between data such as young age, anxiety and body image (Armstrong et al., 2019). In inter-community armed conflicts, patients who suffer amputations often have bilateral or multiple amputations, and most often the injuries are extensive. Although they appear at younger ages, the rates of depression and social rejection are much lower in their case, because the coping mechanisms they benefit from are much better (suffering for the country, admiration from society as heroes, etc.) (Pomares et al., 2020).

Other elements that can influence the psyche after amputation are educational level, social status and income. Patients who have not completed high school generally present pain and depression much more frequently than those who have completed college (Merlo et al., 2020). In terms of income, those with a low standard of living have lower levels of mobility and activity compared

to others, and are therefore more prone to develop symptoms associated with depression (Zhang et al., 2021).

Social and emotional support is one of the most important factors involved in recovery; most studies have concluded that social support can be an essential factor influencing post-amputation outcomes (in young children and adolescents social support has a direct effect on adaptation to amputation) (Michielsen et al., 2022). Thus, if social isolation reaches high levels and the support offered is low, the quality of life of the patients will progressively decrease and the probability of rapid onset of depression increases (Adiyeke & Karagoz, 2022; Rybarczyk et al., 1992).

Personality can also influence the post-amputation condition, sometimes playing an essential role in recovery. Patients who were socially active before the intervention, who were extroverts and constant risk-takers, had a lower rate of depression and a much better social reintegration. Similarly, optimistic patients with high self-esteem also had similar results in terms of recovery and social reintegration (Ostler et al., 2022).

2.4 Impact of amputation level on mental status

Amputation of both upper and lower limbs can be performed electively or as an emergency, sometimes being cases of maximum urgency in which the initial therapeutic approach aims to save the patient's life (traumatic etiology, sepsis). Emergency operations associate the patient with much greater stress, so that the psychological consequences will be much more pronounced (Sahu et al., 2016). The upper limb is involved in several daily activities (personal hygiene, food preparation, carrying out activities in order to obtain income) that patients can no longer perform after amputation. Fingers and palms play an important role in non-verbal communication, social interaction, physical contact, etc. In addition, a prosthesis located at the level of the upper limb is much more visible than a prosthesis located at the level of the lower limb, which is why the social entourage may show reluctance in terms of social interaction (Landers et al., 2018). The upper limb is an extremely complex system of movement and perception. Even with the significant technological progress that has been achieved, the prostheses developed today cannot yet faithfully fulfill the function of the upper limb (they are used especially for the motor function, while the sensory function cannot yet be faithfully reconstructed). In addition, the production costs of such smart prostheses, which must be adapted to each individual patient, are very high, which makes them still prohibitive for the general population (Dudkiewicz et al., 2004).

Regarding the level of amputation, symptoms (depression, anxiety related to body image, lack of social integration) seem to be more pronounced and more frequent if the amputation occurs at the level of the upper limb than the lower, regardless of whether the amputations are major or minor (Karslioglu et al., 2021). Thus, major amputation of the upper limb (transradial/ transhumeral) was associated with high rates of psychiatric symptoms after the operation. Similarly, the amputation of more than 3 fingers, especially if they include the thumb (generally associated with an evolving brand and superior intellectual capacity), leads to early, frequent and severe psychiatric symptoms (Pomares et al, 2020). It is a consequence of the fact that patients consider that with the loss of these essential/defining elements they lose not only a part of themselves, but also their dignity or personality.

Interscapulothoracic (forequarter) amputation is a surgical intervention performed very rarely, with indications for primitive local malignancy with loco-regional extension, failure of local radiotherapy and/or chemotherapy, pathological bone fracture secondary to a sarcoma that does not respond to radiotherapy, marked lymphedema or inflamed tumors with or without necrosis/abscesses (Qadir et al., 2014). It is perceived by the majority of patients (as well as the other operations performed in the proximal region of the arm, such as disarticulation of the shoulder) as being very mutilating, with a major psychological impact not only through the changes in the body structure, but also through the pain given by the phantom limb or through chronic pain at the level of the amputation abutment (Daigeler et al., 2009).

In cases of proximal upper limb amputation, pain related to the phantom limb may be present in up to 86% of patients, resulting in a depression rate of about 65%, of whom approximately 32% have suicidal thoughts (Shukla et al., 1982; Wright et al, 1995). In order to avoid such phenomena and to increase the quality of life of these patients, a good pain management is necessary, which must be initiated before the surgical intervention by injection of anesthetic (either at the level of the brachial plexus or along the nerve path), which has been shown to be able to reduce the risk of phantom limb pain (Stephensen et al., 2019).

Amputation located at the level of the lower limb is most often caused by vascular diseases, but also by traumatic diseases, especially in the young population. Similar to the amputation of the scapula, the largest intervention in the lower body region is represented by the hemipelvectomy, which is indicated in the malignant disease of the bony pelvis or adjacent muscles, operations that associate a fairly high mortality. Hemipelvectomy is most often a mutilating intervention for the patient; may have a prosthetic solution, but 57% of patients refuse to wear it or do not tolerate it (Ku et al., 2019). This is due to the approximately 5 kg weight of the mechanical

system, while the energy necessary to climb a step is approximately double that required by a normal limb (Kurt, 2022). Second, patients with amputations in the proximal region of the lower limb have higher rates of prosthesis rejection, which leads to an increase in mobility. Subsequently, obesity appears, the decrease in the quality of life, an increase in the degree of depression, thus establishing a physiopathological vicious circle that finally makes the prosthesis unacceptable (Resnik et al., 2019).

Patients who have undergone amputations in the distal region of the lower limb are much more mobile than those who have undergone amputations above the knee or bilaterally. This is easily explained by the fact that the level of energy consumed for mobilization is much lower and the prosthesis is made much easier (Houdijk et al., 2021). As for knee disarticulation, it was associated with severe abutment pain, so that the number of hours patients wore the prosthesis was considerably less than in the case of above-knee amputation (Penn-Barwell, 2011).

2.5 Methods of psycho-social rehabilitation of patients with limb amputations

In order to increase both physical and emotional comfort, an extensive recovery program is necessary for the amputee patient. This must include both the postoperative complications (immediate and delayed) of the intervention, as well as their consequences on the patient's psychological and social relationships. Postoperative pain is the first factor that must be controlled to increase the quality of life and reduce the psychological impact on the patient. There are several ways in which this can be achieved through medical, non-medical and surgical procedures (Ghoseiri et al., 2018).

Among the drugs indicated for pain control, most are represented by antidepressants, muscle relaxants, opioid and non-opioid analgesics, etc. (Motofei, 2022b). A study of amitriptyline (a tricyclic antidepressant used in the management of phantom limb pain) shows no improvement in chronic pain after 6 weeks, but long-term administration may have a positive effect with good tolerance of adverse effects (Anghelescu et al., 2022; Robinson et al., 2004). Opioid treatment is indicated in the treatment of acute pain by administration of high doses of morphine sulfate, but with the risk of dependence and tolerance for long-term administration (Robinson et al., 2004). Another promising drug is represented by ketamine, which led to a decrease in pain in the short term, but with the appearance of visual hallucinations in some of the patients and with a very high risk of recreational use (Motofei, 2022b). Non-medical treatment can be administered in the form of application of elastic bands, acupuncture, massage, application of hot or cold compresses, treatments with vibrations or electrical impulses, but all these methods generally have limited results compared to medical treatment (Flor, 2008).

In the class of implantable medical devices, a wide range of technologies have been developed with good results. These are applied in various forms, from electrical nerve blockers to continuous magnetic stimulation and augmented reality systems.

Nerve blockers transmit an electrical signal with a frequency of 10 kHz at a voltage of 10 V to a nerve located in the amputation stump, having relatively good results in pain management (Soin et al., 2015). Another device that has proven effective is the continuous anesthetic infusion pump. It can infuse exact amounts of analgesic substances either on demand or continuously into the epidural/ subarachnoid space, but with a significant risk of associated infections and also at high cost. All these shortcomings led to the development of devices that instill near the sciatic/anterior tibial nerve a certain/dosed amount of nerve blocker, thus largely excluding the risk of infections (Bosanquet et al., 2015).

Augmented reality systems can be used separately or in combination with nerve stimulation systems to reduce pain (Cole et al., 2009). Via motion sensors mounted on the affected limb, a normal image of the affected limb is reconstructed, which is transmitted to the patient's cortex with the help of augmented reality glasses. In this way the patient can recognize the limb, relieving the pain and unpleasant sensation (Makin & Flor, 2022), a fact confirmed both clinically and by nuclear magnetic resonance imaging (Imaizumi et al., 2017).

Surgical treatment is used as a last resort for pain relief, which can range from cordotomy to nerve reimplantation or even deep brain stimulation. The effectiveness of the latter remains to be investigated in large groups of patients, as in a small number of patients the results seem to be satisfactory in terms of analgesia (Makin & Flor, 2022; Motofei, 2022b).

Coping mechanisms are very useful in alleviating the distress caused by the traumatic event that patients have experienced. Most of these are based on behavioral changes and the introduction of new activities, which must of course be accepted by the disabled person. It is necessary to progressively implement such procedures/techniques, until they are carried out regularly and to a certain extent. If the adopted method does not prove its usefulness within a reasonable time, the patient generally tends to abandon it. On the opposite end, if the technique is performed incorrectly and in excess, it can lead to fatigue and implicitly to its abandonment. It has been observed that one of the first skills that an amputation patient must develop is relaxation. This can lead to the reduction of anxiety, depression, and last but not least, pain (Belon & Vigoda, 2014). The simplest method is diaphragmatic breathing. This should be performed approximately 3 times per hour, as much as possible as an automatic gesture. It is necessary to create mechanisms to remind the patient, who only needs to initiate the technique and not to

focus on its course. It is recommended that the exercise be done in a comfortable place, lying on your back and watching how the abdomen rises and falls. There are other relaxation methods that can be used such as visualizing a beautiful place where you can go on vacation, yoga exercises and relaxing music, etc. (Caputo, 2020).

Acceptance is a crucial element in post-amputation recovery. They must be taught to focus on what they can change in life, while minimizing the things they cannot control. So, patients are taught to focus on what they can change, because a sense of empowerment can develop, thus being able to set goals both in their professional status and in their family life (the primary essential conditions still remaining a realistic/primary purpose). Many amputees have surrendered control of their lives to a higher power such as God. In this way, they believe that the traumatic event they went through is part of a plan that is difficult to understand at the level of the human existence. In this way their life acquires a deeper meaning, reaching in turn to want to help those around them (including voluntary activities, where they can benefit from the presence of support groups) (Belon & Vigoda, 2014).

Sports can be a factor that leads to an increase in the quality of life, a better communication and an improvement in the psychological state of amputees (Cavedon et al., 2022; Ichimura et al, 2022). Through the use of questionnaires, it has been shown that patients who participated in team sports and other collective mental activities have a much better quality of life and self-esteem compared to the inactive population (Kasińska et al., 2022). Sports are a way to find mental support and empathy from peers or other community members. Finally, patients not only accept the disability more easily, but at the same time can improve their mobility capacity (Couture et al, 2010).

Social support is very important in the rehabilitation and integration strategy of the amputee patient. Amputees who receive or can ask for emotional or physical support from family or friends accept their situation better and faster. There are also patients who do not accept to be helped, but such an attitude is usually transitory and, in the end, patients will accept the help if it is offered in good faith. To achieve this, patients need to express their feelings and communicate, existing real benefits from group therapy through both physical meetings and social media. For example, the American Amputee Coalition offers online support and workshops for amputees (Belon & Vigoda, 2014). Social and professional reintegration are interconnected, so it is important that the amputee can return to work. In most cases, the loss of a limb leads to the inability to perform sustained physical work. Consequently, it is recommended that the patient not lift weights greater than 15 kg, nor work near moving

vehicles. It is preferable for patients to change their workplace if they have to climb stairs or jump. For a good reintegration, it is ideal for the patient to carry out a complete rehabilitation program for at least 5 days. After that, it is recommended to resume part-time work for a period of time, so that the rest of the day in which the patient does not work can be allocated to sports or social activities (Esquenazi & Di Giacomo, 2001).

3. Conclusions

Limb amputations generally have a significant psychological impact on the patient, especially if such an event occurs suddenly and in full health. Loss of a limb also leads to physical disability, changes in physical appearance and self-image/esteem, difficulty returning to work and problems with social integration. Consequently, after an amputation operation, the patient's recovery is very difficult. Perhaps the most important thing is to induce and maintain the patient's motivation (through activities, hobbies, pleasures, goals, etc.) to adapt to the new condition, which could help him to be able to continue his life in all its aspects.

Finally, the rehabilitation of patients depends on many factors (personality type, area and degree of amputation, level of education, age, sex, environment and culture, accessibility to different recovery methods, etc.). This complexity of factors means that the rehabilitation program for amputees must be not only extremely elaborate, but also highly personalized according to individual characteristics.

Conflict of Interest Statement

The authors declare that the research was conducted in the absence of any potential conflict of interest.

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