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Mini Review

Understanding the Secondary Effects of Amputation

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ABSTRACT

Amputations have taken place for thousands of years. Despite their potential to save lives, amputations come with serious health consequences, including increased risk for pain, psychopathology, injury, degeneration, and disease. Those who undergo amputation are often in need of significant aid and attendant care. It is critical to balance the reasons for pursuing amputation with the inevitable risks before choosing amputation.

Keywords: Amputation; Pain; Trauma; Health; Joint; Muscle

INTRODUCTION

Amputations have taken place for at least 45,000 years, and since they began, patients have suffered the devastating consequences of these procedures [1]. Today, there are 2 million people in the U.S. living with a lost limb [2]. By 2050, it is estimated that 3.2 million people in the U.S. will require limb amputation [3].

Amputation is pursued for several reasons including to address infections, tumors, burns, peripheral vascular disease, trauma, and frostbite [1]. In the most extreme cases, the procedure is intended to prevent death. Otherwise, justifications for amputation include controlling pain and reducing morbidity risks associated with a given condition. However, despite potential clinical benefits, there are several downsides to amputation, including the risk for chronic pain, psychiatric disturbances, compromise of bone and muscle, cardiometabolic disorders, and dermatologic conditions [4-7].

Given the prevalence of these procedures and their significant impact on quality of life, it is critical that before pursuing amputation, healthcare providers and patients themselves consider the aftermath of these surgeries and the long-term risks associated with limb removal. Here, we review some of the most common adverse outcomes that plague amputees to suggest some of the primary risks that should be balanced against potential benefits before amputation is pursued.

THE VAST MAJORITY OF PEOPLE WHO UNDERGO AMPUTATION EXPERIENCE DIFFICULT-TO-TREAT PAIN

Postamputation pain is very common following limb amputation, both post-operatively and over the long-term is difficult to treat [1,7-9]. An estimated 95% of people with amputations experience pain either in the residual stump or through phantom limb pain [10].

Pain in the residual stump can derive from several factors, including deep tissue infections, bone spurs, pressure points, or neuroma formation [11]. At the cellular level, inflammation resulting from axonal nerve damage contributes to pain in the residual stump [1].

The severity of residual stump pain appears to depend on the etiology of the amputation and occurs more frequently following upper extremity amputation [12]. Postamputation pain is reportedly most severe in amputations conducted due to cancer and trauma, whereas less severe pain is associated with vascular amputations.

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Phantom pain, which was coined when a physician recognized the condition in as many as 90% of his civil war amputees, occurs due to somatosensory cortical reorganization in areas of the brain that represent the amputated limb [1,13-16]. Phantom limb pain has now been observed in patients even 30 years following amputation [17]. Research examining the prevalence of postamputation phantom pain has also found that 60% of patients continue to experience phantom limb pain seven years after their amputation [17].

Pain that lasts more than seven months is incredibly difficult to treat and often does not respond to even strong analgesic agents such as opioids [17]. Thus, the chronic pain following amputation can be debilitating and have a significant adverse effect on quality of life, including disrupting sleep and normal daily functioning, and leading to a psychopathological state [11,17].

AMPUTATION OFTEN LEADS TO PSYCHOPATHOLOGY, INCLUDING DEPRESSION, ANXIETY AND LOSS OF SELF-ESTEEM

The importance of limb integrity to psychological well-being is well-established. Even severe limb injuries that do not necessarily involve amputation are associated with depression and anxiety, with those suffering these injuries experiencing severe depression at rates approximated at 38% and anxiety at nearly 30% [18].

Research into the psychological effects of amputation has shown that the psychological disturbances that amputees suffer are associated with a variety of factors including the pain they endure, the etiology of the amputation, and their inability to accept a prosthesis [19,20]. For instance, research has shown that major depressive disorder is more likely in those who lose a limb due to disease than due to trauma [7].

To a greater extent than other limb injuries, amputation is perceived as an aggression against the body's integrity, which can lead to severe psychological consequences [20]. Specifically, depression, anxiety, and loss of self-esteem commonly follow amputation [19,20]. According to the World Health Organization (WHO), twice as many female amputees report depression compared to male amputees [19].

In addition to the frustration associated with their physical challenges, amputees tend to have an intense emotional response to changes in sensation and body image that accompany amputation [21]. Patients who experience traumatic amputation, for instance, often endure shock associated with the unanticipated loss and significant difficulties adapting to their new body [21]. The psychopathology following amputation may also be compounded by the reaction of those around the amputee, as amputees have been reported as being socially ostracized [1].

Psychological impairments have been shown to occur in connection to both upper and lower extremity amputations [22]. However, the psychological effects of amputation may be stronger in those with lower extremity amputations compared to those with upper extremity amputations owing to the greater impact on daily life. One study found that 27% of patients with lower extremity amputations displayed increased depression following their amputation, while 25% had higher anxiety, and nearly one in five experienced increased levels of both depression and anxiety [19].

AMPUTATION ALTERS BODY MECHANICS, INCREASING RISK FOR INJURY AND DEGENERATION

Whether an amputee has a prosthesis or not, their body mechanics are altered, rendering the body primed to maneuver differently as it navigates its physical environment [23]. These changes in body mechanics are associated with enhanced fall risks and other health-related complications that often increase the need for aid and attendant care.

For instance, the intact limb is often favored and stressed at a high rate during daily activities, leading to overuse and degeneration in the intact limb, which increases risk for joint contracture and osteoarthritis [7]. At the same time, the lack of use of the residual limb can lead to osteopenia and osteoporosis due to a lack of sufficient loading on the bone.

Chronic back pain is another common consequence of compensating for changes in body mechanics that occur following amputation. This challenge is particularly prevalent in lower extremity amputees that have difficulty aligning or using their prostheses or who have discrepancies in leg length [23].

DISCUSSION

Amputation enhances energy expenditure, with adverse health consequences

In addition to the complications discussed above, the body mechanics changes that occur with amputation also lead to a modulation in energy expenditure requirements that are associated with metabolic health deterioration. Coronary artery disease and diabetes, for instance, may be exacerbated by increased energy consumption associated with amputation. The metabolic changes and enhancements in energy expenditure requirements in amputees likely contribute not only to physical limitations but also to compromise of professional lives and deterioration of psychological health [24].

The level and type of amputation affects how much more energy is expended by the amputee. For example, lower extremity amputations are associated with higher increases in energy expenditure compared to upper extremity amputations, and bilateral amputations are associated with higher increases in energy expenditure compared to unilateral amputations (Table 1) [25].

Specifically, unilateral transtibial amputations are associated with at least a 20% increase in energy expenditure, while unilateral transfemoral amputations are associated with at least 60% increase in energy expenditure. Those with unilateral transtibial and unilateral transfemoral amputations experience energy expenditure increases of nearly 120%. Meanwhile, bilateral transtibial amputations lead to an increase in energy expenditure of 41%, and bilateral transfemoral amputations result in energy expenditure increases of over 200%.

Table 1: Energy expenditure increases by amputation type.

Unilateral amputation type	Energy expenditure increase
Transtibial	20+%
Transfemoral	60+%
Transtibial+Transfemoral	118%
Bilateral amputation type	**Energy expenditure increase**
Bilateral transtibial	41%
Bilateral transfemoral	More than 200%

Research shows that 65% more energy expenditure is required in above-knee amputees to produce only half speed ambulation compared to those without amputations [26]. In cases where amputation results from vascular computation, energy expenditure increases may be as high as 100%.

Both lower and upper-level amputations are associated with increased energy expenditure during walking and an overall reduction in walking speed and efficiency, which tend to lead amputees to reduce their ambulatory physical activity [18,27]. One study found that the walking speed of those with unilateral transfemoral amputation was 8.6% slower than that of non-amputees, while another found that oxygen consumption during ambulation was increased 49% in above-the-knee amputees [27].

Above-knee lower extremity amputations carry the most risk to overall health and well-being

Each year, approximately 150,000 people in the U.S. undergo amputation of a lower extremity [28]. Out of every 100,000 people, up to 31 undergo lower extremity amputation, making this surgical intervention one of the most frequently performed worldwide [11]. For several of the reasons discussed above, lower-limb amputees are at a heightened risk for cardiometabolic disease in addition to several other comorbidities [18].

While all amputations carry significant physical and psychological risks, above-knee amputations are associated with some of the most significant challenges. For instance, compared to below-knee amputation, above-knee amputations are much more difficult to properly fit for prostheses [29]. Thus, above-knee amputees are the most likely to default to a wheelchair for mobility. Once a patient is in a wheelchair, risks for several complications are introduced. For example, amputees in wheelchairs are at heightened risk for pressure sores, avoidance of normal daily activities, and depression [29].

To prevent the complications associated with ill-fitting sockets, osseointegration is gaining traction and will help appropriate amputees to enjoy a better quality of life with less pain and fewer comorbidities, such as skin breakdown and phantom pain [30]. It must be realized that with the use of osseointegration, there is no socket, which decreases the weight of the prosthetic device, requires less energy to ambulate, and, with lower extremity amputations, the patient will benefit from osseo-proprioception.

CONCLUSION

Amputation is a common surgical procedure used to address a variety of clinical challenges. However, the urgency for amputation is not equivalent across patients, and given the dire consequences of losing a limb, it is critical that careful consideration be dedicated to weighing the potential benefits and risks to each individual patient before encouraging a patient to undergo amputation.

Regardless of the clinical reasons for amputation, amputation is likely to result in significant long-term pain and psychological hardship. Because of the changes in body mechanics each patient will endure, the body will suffer from compensatory behaviors that can compromise cardiovascular health as well as the bones, muscles, joints, and skin.

Because above-the-knee lower limb amputees tend to have their lives disrupted more so than other amputees, this patient population is particularly vulnerable to poor physical and psychiatric outcomes. Thus, in the case of above-the-knee amputations, extra caution should be used in determining whether an amputation is necessary and if there may be another potential intervention to address the patient's morbidities.

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