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Low-Cost, Low-Risk Treatment of Residual Limb Phantom Pain in a Military Amputee Using Osteopathic Manipulative Medicine Techniques

Danyel Roxanne Baker*, James Robert Palmieri, David Gardner Harden, Stephen Douglas Blood, Michael Richard Mabry, Benjamin Thomas Canipe, Wallie Martínez-Vega

Edward Via College of Osteopathic Medicine, 2265 Kraft Drive, Blacksburg, Virginia, USA

Email address

dbaker@vt.vcom.edu (D. Baker), jpalmieri@vcom.vt.edu (J. R. Palmieri), malaria@cox.net (J. R. Palmieri)

*Corresponding author

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Abstract: Amputation of a lower limb is a stressful experience for any amputee and requires physical, psychological and social adjustments. Since the start of the Iraq war in 2003, military troop personnel have suffered blast injuries, most were attributed to ground-placed IEDs or land-mines. An emerging pattern of high, multiple extremity amputations have established on the battlefield, involving the lower limbs. There are numerous approaches for the treatment and management of Phantom limb pain (PLP). This case involves a 35 year-old active duty U.S. Army Sergeant with six combat deployments to Afghanistan, who underwent a right lower extremity, below the knee amputation during July 2017. The patient underwent osteopathic manual manipulation therapy as treatment and management of his extensive PLP. Two weeks post-operatively, the patient experienced excruciating PLP. Cranial Rhythmic Impulse (CRI) was noted as a palpable symmetric wave form in normal tissue. When the patient's PLP initially began, the primary practitioner was curious as to how the amputation might have affected the CRI through the residual limb, and whether these changes could be manipulated to decrease the patient's perceived PLP. The impulse was stronger on the medial side when compared to the lateral side, and the impulses differed in timing when comparing right to left. The patient immediately experienced relief from his PLP to the point of falling asleep during the session. Due to the patient's perceived success of this first session, the technique was repeated several times over the next eight weeks. Even when considering the inherent confounding factors and bias in this case report, the patient did experience immediately relief from his over eight weeks. This factor alone demands that OMM, OMT and OCMM techniques be further investigated for PLP as a treatment modality. The best services to support military and veteran amputees, as well as other non-military amputees, would be to have available low cost and low risk treatment and management solutions.

Keywords: Amputee, Cranial Osteopathy, Craniosacral Technique, Indirect Myofascial Technique, Indirect Technique Military Amputee, Osteopathic Manipulative Medicine (OMM), Osteopathic Manipulative Treatment (OMT), Phantom Pain

1. Introduction

Amputation of a lower limb is a stressful experience for any amputee and requires physical, psychological [1] and social adjustments on the part of the amputee and adjustments for family members. [1-3] The causes of lower extremity amputation are numerous ranging from vascular causes due to ischemia, diabetes, frostbite, arterial insufficiency leading to death and decay of tissue (gangrene); bone infection (osteomyelitis); malignant tumors such as sarcoma of cancer of the connective tissue; and trauma including accidents, gunshot wounds, animal bite, stabbings, mechanical crushing. [4-9] Amputations are a growing issue worldwide with numerous causative factors. [1] It is a challenge to accurately estimate the incidence and prevalence of amputations because of factors which include the lack of standardized reporting and limited medical access. A

document published in 2015 by the World Health Organization (WHO) estimated that 110-190 million people, including 93 million children, are currently living with disabilities which significantly limits their functionality. [6, 10-11] Studies report that 80% of these individuals reside in developing nations and have decreased access to affordable medical support. [9, 10-11]

Since the start of the Iraq war in 2003, military troop personnel from the United States of America along with NATO forces including the United Kingdom, France, Germany, Spain, Australia, and New Zealand, have suffered blast injuries, most were attributed to ground-placed Improvised Explosive Devices (IED) or land-mines, with 88% of survivors being on foot. An emerging pattern of high, multiple extremity amputations have established on the battlefield, especially involving the lower limbs, associated pelvic, abdominal or genital-urinary injuries. [12-13] In a short communication by Duncan Wallace (2014) he reported that by 2010, blast injuries to US Forces in Iraq declined to near zero from a peak prevalence of 3.3 per 10,000 and during mid to late 2010, a significant increase in blast injuries to US personnel in Afghanistan emerged. [13] The impact of losing a limb in military service extends well beyond initial recovery and rehabilitation, with long-term consequences and challenges requiring health-care commitments across the patient life-course, and involving veteran services, community health care facilities, and numerous military support organizations. [14-17]

The management and treatment of phantom limb pain (PLP) resulting from lower limb amputation are sometimes difficult and ineffective with 50-80% of amputees experiencing PLP for many months and sometimes over their lifetime. [13, 18] This topic has been extensively reviewed by Richardson and Kulkarni (2017). [2] Numerous factors associated with phantom pain include both physiological and psychological. [1, 18] A combination of factors caused by the actual amputation and the associated phantom pain resulting from the amputation include: emotions, depression; anxiety; stress and tension; cognitive factors including memory, beliefs; coping strategies; pain catastrophizing; changes in body perception, recurrent pain; and fear. [1, 19-20]

Presently, there are numerous approaches for the treatment and management of PLP, although mechanism-based specific treatment guidelines are yet to evolve. [21] As reported by Subedi and Grossberg (2011) most successful treatment outcomes are multidisciplinary in nature involving one or more of the following: pharmacotherapy, surgical intervention and various adjuvant therapies, yet there is no unifying theory explaining the mechanisms for PLP. This factor makes it difficult to establish a specific mechanism-based treatment approach to PLP. [21-22] Many of the reported approaches to treatment are ineffective or partially effective, expensive, time-consuming and may add additional health risks to the recipient patient. This is especially true when opioids, ketamine or other potentially addictive drugs are used. [23-24] Many of the surgical and invasive procedures, such as stump revision, neurectomy, rhizotomy, cordotomy, lobectomy, and sympathectomy may be ineffective and add additional risk factors for the amputee patient with severe PLP. [21-22, 25]

In this study, we report a novel approach to phantom pain management which is low cost and low risk to the amputee. This case involves a 35-year-old active duty Army Sergeant with six combat deployments to Afghanistan, who underwent a right lower extremity, below the knee amputation during July 2017. The patient underwent osteopathic manual manipulation therapy as treatment and management of his extensive PLP. The authors recognize the limitation of this study, but because the treatment was low cost and low risk to the patient and the treatment was successful, we feel the need to report this case in hopes that others can duplicate the results in larger and more refined studies. Successful replication of the results reported in this case may have significant benefit to military and veteran amputees as well as to other amputees suffering from PLP. To our knowledge, osteopathic manipulative therapy has not been tested before to assist patients with PLP.

2. Case Report

2.1. Patient Information

The patient is a 35-year-old male, Active Duty Army Sergeant First Class with 17 years of service, including six combat deployments to Afghanistan as a Special Operations Multipurpose K9 Handler. The patient's past medical history included several blast exposures, one of which resulted in a concussion and traumatic brain injury (TBI). His past surgical history included bilateral subtalar joint fusions following an injury sustained during a military training exercise in 2001, and cervical spine fusion with cervical disc replacement in 2014. Over time, the patient's right subtalar joint fusion failed, causing significant and often debilitating pain in the right foot and ankle. During December 2015, the patient underwent a surgical revision of the failed right subtalar fusion, a surgery which resulted in increased pain, significant swelling, decrease in range of motion in plantar and dorsiflexion, as well as a decrease in flexion and extension of the right great toe. The orthopedic surgeon suggested the patient use an Intrepid Dynamic Exoskeletal Orthosis (IDEO) to offload the affected joint and decrease pain. While the IDEO did reduce the amount of pain experienced by the patient when ambulating, the orthotic was not effective in relieving the patient's day-to-day pain. It was at this time the patient aggressively pursued the option of limb salvage through the military medical system at Walter Reed National Military Medical Center in Bethesda, Maryland. The patient underwent a right lower extremity below the knee amputation during early July 2017 and was discharged from the hospital with femoral and popliteal peripheral nerve blocks which were removed approximately two weeks post-operatively. Shortly following, the patient began to experience PLP which was distinct from the surgical site pain. The PLP was described as waxing and

waning, occurring several times per day, and lasting several minutes to several hours in duration. The pains were characterized as muscle spasms, stabbing, and burning sensations, feelings of an electrical shock, and ankle sprain or strain. These painful sensations were described as originating from specific, pinpoint locations on the phantom limb, each time in a discrete place which varied in location, timing, and intensity. During this time, the patient was undergoing physical therapy (PT) and occupational therapy (OT). Both PT and OT taught the patient various desensitization techniques using sponges and tapping, as well as mirror therapy to relieve his PLP. The patient reported that these techniques provided little to no relief.

2.2. Caregiver Background Information and Qualifications

The primary author of this report began her medical education and training as a future Doctor of Osteopathy, embracing the effectiveness of Osteopathic Manipulative Treatment (OMT). She attended OMT and Osteopathic Cranial Manipulative Medicine (OCMM) conferences and workshops, taught by Dr. Stephen D. Blood DO, Rehabilitation Specialist located in Alexandria, Virginia, USA. During the primary author's first OCMM Workshop, as a first-year medical student, she learned about and experienced the natural ebb and flow throughout the human body termed the Cranial Rhythmic Impulse (CRI). The CRI is noted to be present as a palpable symmetric wave form in normal tissue. When the patient's PLP initially began, the primary author was curious as to how the amputation might have affected the CRI through the residual limb, and whether these changes could be manipulated to decrease the patient's perceived PLP.

2.3. Patient Treatment

Approximately two weeks postoperatively, the patient experienced excruciating PLP as described above. During the first treatment, hands were lightly placed on the residual limb, as shown in Figure 1.

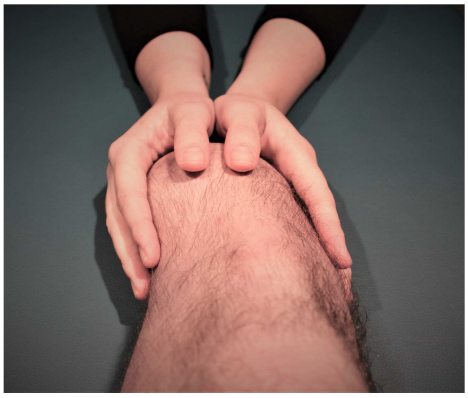

Figure 1. *Hand placement on the residual limb. This hand placement is similar to the vault hold used during traditional OCMM. The fourth and fifth digits are on the posterolateral and posterior aspects of the residual limb, respectively.*

CRI was identified by palpation through the residual limb. The impulse was stronger on the medial side when compared to the lateral side, and the impulses differed in timing when comparing right to left. The effort was concentrated on using indirect energy techniques [26] to balance the timing and intensity of the impulses. While performing this technique, the patient immediately experienced relief from his PLP to the point of falling asleep during the session. Due to the patient's perceived success of this first session, the technique was repeated multiple times over the next eight weeks when the patient reported having intense PLP. Each session lasted approximately 15 to 20 minutes, during which time the patient experienced pain relief to the point of falling asleep. Although decreased, the pain, unfortunately, returned within several minutes of the conclusion of each session but the PLP was eventually self-limiting. During the times when the PLP was reported as tolerable, the treatment technique was not performed. The goal in performing these sessions was to ascertain whether the CRI could be palpated in a residual limb. If it could be palpated and was found to show abnormalities in the normal symmetric rhythmic form, could the asymmetry be influenced?

The last session occurred shortly before the patient received his first prosthesis. No further OMT sessions were performed by the primary author once the patient began treatment with Rehabilitation Specialist, Dr. Stephen D. Blood who treated the patient with OMT several times over the following weeks. Dr. Blood's treatments were focused on correcting somatic dysfunctions throughout the whole body, not just the residual limb. The patient's first encounter with Dr. Blood occurred August 30, 2017, eight weeks post-operatively. According to a conversation with Dr. Stephen D. Blood (Personal communications, October 2018), the patient's chief complaints were phantom limb pain, occasional generalized headaches, and difficulty initiating sleep. In addition to the injury which leads to the eventual amputation, history revealed several close proximity blast injuries sustained by the patient while in Afghanistan. The patient reported closed head injuries due to several instances in which the patient was near explosions. On one occasion after being thrown from the vehicle when it was blown up by an IED, the patient sustained a concussion and TBI. The physical exam during this first encounter revealed unspecified restrictions in the residual limb and a severe sphenobasilar synchondrosis (SBS) compression dysfunction. Sphenobasilar synchondrosis compression is a somatic dysfunction wherein the basiocciput and basisphenoid are held tightly together which limits the normal physiologic motion at the SBS. This particular dysfunction has been observed in patients with a history of direct head trauma and other physical and psychological insults. [27-29] Dr. Blood addressed the restrictions in the residual limb using the previously described CRI. The SBS compression somatic dysfunction was treated by Dr. Blood, with the help of two colleagues, using the SBS Decompression Technique, as previously described in the literature. [27-29] The goal of this treatment is to free restrictions around the SBS to restore

physiologically normal motion, thereby relieving any associated symptoms caused by the compression dysfunction. [27] According to Dr. Blood (Personal communication), although decreased in severity each time, the SBS compression dysfunction required three separate treatments before resolution. Over the course of these treatments the patient had progressive improvement in the areas being treated. Following each treatment session with Dr. Blood, the patient reported a feeling of overall wellness and a decrease in both phantom and generalized pain as well as an easier time initiating sleep. Throughout this period and beyond to the present day, the patient reports a significant reduction in the frequency and intensity of his PLP. At the time of this writing, 15 months postoperatively, the patient still reports experiencing PLP however, the pain occurs only a few times per week, not daily; they last only a few seconds to few minutes, not hours; and rarely are they as intense as they were in the first several weeks following amputation.

3. Discussion

Multiple modalities have been attempted when trying to treat PLP. Such treatments include physical or occupational therapy, analgesia medications, mirror therapy, tactile stimulation, psychological therapy, or a combination of multiple therapies. [30] Mirror therapy and tactile therapy has recently been shown in Cambodia to help more than 50% of its participants benefit from treatment while other studies have also shown benefits to mirror therapy. [31-32] Some medications have been used with inconsistent results including Amitriptyline and Gabapentin. Most other current options involved neuromodulation and neuroprosthetics, which attempts to retrain the central nervous system on how to *think* about their lost extremity. [21, 33] As previously discussed, many of these treatments may be ineffective and may add additional risk factors for amputee patients with severe PLP. The use of OMM, OMT, and OCMM introduces little to no short-term or long-term risk factors for the patient with amputation induced PLP, and these procedures are relatively inexpensive when compared to pharmacotherapy, surgical procedures, and many of the adjuvant therapies available. [21]

According to the primary author, following the first hands-on treatment session, a preliminary search of the published literature for OMT related to PLP treatment produced no published report. Most reports encountered by the authors of this study included only a few massage therapy business websites which mentioned the use of Cranial-Sacral techniques to treat PLP. One study suggested balancing the CRI, between the skull and the sacrum, to circulate the cerebrospinal fluid and bathe the spinal cord might aid in the treatment of phantom pains. [30] This was a method of treatment that the primary author (DB) was unable to perform but is of future interest as a potential dual therapy of specifically focusing on the CRI of the residual limb along with the treatment of the CRI from a Cranial-Sacral and whole body standpoint, as is seen in OMT in general and Osteopathic Cranial Manipulative Medicine (OCMM) in particular. The Cranial Rhythmic Impulse (CRI) is the palpable inherent cyclic motion of the Central Nervous System (CNS), Cerebrospinal Fluid (CSF), and associated dura, functioning as a unit with the sacrum and the mobile bones of the cranium. [33-34] Most osteopathic resources state that the cycles occur at 10-14 per minute in the healthy patient, while individuals with biological and/or psychological insults will have variations in both the frequency and amplitude of the CRI while mostly in the vault position. [35-37] CRI can be palpated in the Peripheral Nervous System (PNS) via CSF movement through myelinating Schwann cells. [38-41]

The manual approach to treatment in this case can be considered a more subtle form of indirect technique. The general definition of an indirect technique being a manipulative treatment in which the restrictive barrier of the tissue or joint being treated is disengaged, and the dysfunctional body part is moved away from the restrictive barrier. In the approach of our case, while an indirect approach is being employed, the practitioner is also actively monitoring the CRI waveform for areas of asymmetry and dysfunction within the extremity being treated. The practitioner in this case influences directional changes to the areas being treated to alleviate myofascial restriction. [42] In this case the treatment endpoint point is not necessarily when the tissue is placed in a position of ease as in traditional indirect technique but when the practitioner palpates a more symmetric motion of the CRI in the tissue being treated. The palpation of a return of symmetric CRI may occur while there are still myofascial restrictions present.

4. Conclusion

Studies suggest rates of amputations are increasing worldwide for a variety of reasons. [9] Amputation procedures save lives and ensuring patients have the ability to return to near-normal function in society as they reintegrate into their community. This statement is as true for underserved populations in the developing world as it is for active and veteran military personnel in the USA and other supporting countries. Emphasis on preventative measures includes, but is not limited to, patient education for diabetes and vehicle safety, improving wound care, and assisting war-torn areas to remove landmines is paramount. When amputation of a lower extremity is necessary, affordable low risk and low-cost treatment solutions for psychological, physiological and PLP is required for maintaining an attainable standard of care for all. There are numerous foundations for example, as the Hope To Walk, which support affordable prosthetic devices for the underserved in countries such as Honduras, Guatemala, Haiti, and Vietnam and many private and federally funded organizations such as the U.S. Department of Veteran Affairs with over 1,700 hospitals, clinics, community living centers, domiciliaries, readjustment counseling centers, and other facilities available

to support amputees. The best services to support the military and veteran amputees, as well as other non-military amputees, would be to have available low cost and low-risk treatment and management solutions.

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