

## Current Theories and Treatments Related to Phantom Limb Pain

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**Editor's Note:** This article is a term paper which the author wrote while a student at the Northwestern University Prosthetic-Orthotic Center. The quality of the paper is an attribute to the new generation of orthotists and prosthetists. More articles written by students will be published in this journal in order to encourage students to excel in written communication, and because many of these articles are a real contribution to the literature in this profession.

### INTRODUCTION

Since the great French military surgeon Ambroise Paré first described what was to become known as phantom limb sensation, in 1554, the presence of phantom limb has been reported almost universally. Phantom limb sensation may be defined as the conscious feeling that a limb is still present after amputation. This "conscious feeling" was the topic of a recent study by P.L. Carlen et al, in which seventy-three amputees were interviewed in order to determine exactly what their sensation felt like. It was discovered that nonpainful phantom sensations were described as the normal feeling of a healthy limb in 22% of the cases, 18% felt a mild pins and needles or prickle feeling, and the remaining 60% described sensations from a mild constant electrical current to tickling. Since these patients were in no distress, and it is well known that most phantom sensations decrease in time, no treatment was necessary. However, included in this group of

seventy-three patients were a number of amputees who experienced phantom limb pain.

Phantom limb pain may be defined as the conscious feeling that a very painful limb is still present even after amputation. In Carlen's study, 50% of those patients complaining of pain described it as constant knife jabs or a strong electrical current, 12% felt as though the limb was on fire, and others described sensations such as crushing and bad cramps.<sup>1</sup> Phantom limb pain is estimated to be experienced in three to five percent of the amputee population.<sup>2</sup> Since these patients are usually in extreme distress (some have been known to commit suicide), it is of paramount importance that its mechanism of control be understood and an effective cure discovered.

This paper will first discuss the history of the term phantom limb, and then attempt to tie together some of today's more popular theories and treatments.

As previously stated, the presence of phantom limb sensation can be traced in the literature as far back as 1554 in the notes of Ambroise Paré. However, credit for the term "phantom limb" goes to the 19th century author S. Weir Mitchell. In an article written for the *Atlantic Monthly* in 1866, Mitchell wrote about Mr. George Dedlow, a fictitious quadrilateral amputee who took part in a spiritual seance in Stump Hospital, Philadelphia. The story states that a Sister Euphemia, acting as the medium, received a message from the spirit world which she tapped out on the table; the taps spelled out "United States Army Medical Museum, Nos. 3486, 3487" which happened to be the numbers given to



Dedlow's legs. After this occurrence, Dedlow began to feel "re-individualized" and to the amazement of everyone present, arose and staggered across the room on *limbs invisible*. Many people who read this story apparently thought it was a true account and sent donations to Stump Hospital on behalf of the fictional George Dedlow. This response prompted Mitchell to write another magazine article titled "Phantom Limbs" to set the record straight.<sup>3</sup>

## THEORETICAL CASES OF PHANTOM LIMB

Today there are three main theories which attempt to describe the mechanism behind S. Weir Mitchell's phantom limbs. They are the Central or Gate theory, the Peripheral theory, and the Psychologic theory.

### GATE THEORY

The Gate theory of pain, published in 1965 by Melzack and Wall, has received much attention. This theory proposed that the dorsal horns in the spinal cord act much like a gate, being capable of modifying somatosensory input before perception and response occur. Melzack and Wall suggest that the altering of input by this neural mechanism is determined by the activity of A-beta, A-delta and C fibers (motor neurons), the whole being under the control of descending impulses from the brain, which act to inhibit the neural mechanism. Melzack wrote that the loss of sensory input after amputation would decrease the inhibition from the brain and therefore increase the self-sustaining neural activity of the gate, thereby causing pain.<sup>4</sup> The actual location of the neural mechanism is a rather large controversy among neurosurgeons today. It is from this theory that treatments such as electrical stimulation, dorsal column stimulation, and various drug treatments have originated.

### PERIPHERAL THEORY

The peripheral theory of phantom limb pain is much less developed and therefore much less accepted when compared to the gate theory. Stated simply, the peripheral

theory proposes that persisting sensations from nerve endings in the stump are assigned to those parts originally innervated by the severed nerves. This is also called referred or projected pain. Projected pain results from the fact that a stimulus applied to a peripheral nerve anywhere along its axon, causes impulses that are indistinguishable from those that originate at the receptors formed by fibers of that nerve. Unfortunately, complete analgesia of the peripheral nerve, or even posterior rhizotomies, in patients with phantom pain have not given satisfactory results in curing the pain, which if the peripheral theory were true, one would not expect to happen.

Another version of the peripheral theory credits phantom pain to possible changes in the central nervous system resulting from peripheral nerve injury. This faction theorizes that the phantom may result from the partial deafferentation and disordered reinnervation of spinal cord cells.<sup>5</sup> As this concept contradicts wallerian degeneration, more research in this area is needed.

### PSYCHOLOGIC THEORIES

Psychologic theories all tend to relate phantom sensation to "wish fulfillment" which results from the denial of the loss of a part, and phantom pain is described as resulting from denial of affect associated with the loss. Lawrence C. Kolb, a psychiatrist, has done much work with amputees suffering from phantom pain. He states, "the chronic painful phantom limb represents an emotional response to the loss of an important body part that is significant in the patient's relationship with others. Hostile feelings, with resulting guilt, develop toward those with whom the patient identifies as mutilating or mutilated and also toward those on whom he is dependent and whose rejection he fears. Pain may result from punishment for such hostile and guilty emotions."<sup>6</sup>

Parkes, also a psychiatrist who has worked with amputees complaining of pain, views the phantom limb as part of a mourning syndrome—"Just as the widow finds it hard to believe that her husband is dead and often has a strong sense of his presence, so the amputee has difficulty in accepting the loss



of his limb and he continues to feel it is present.<sup>7</sup>

Part of the mourning syndrome is fantasy. Amputation arouses fantasies of personal mutilation (of the removed limbs) that are overcome by repression. An example of how repressed fantasies can cause phantom limb pain is illustrated by the case of a 14 year old boy who suffered severe phantom pain following amputation of a lower extremity due to osteogenic sarcoma. During an interview with a psychiatrist it was learned that the boy heard, from one of his school teachers, a story of a man in whom stinging pain had developed in a phantom limb. The man was informed that his amputated leg was being devoured and stung by ants. The pain stopped when the ants were removed. When asked what the boy thought had happened to his leg, he stated he thought it had been burned up. After being assured otherwise, his complaints of pain subsided.<sup>8</sup>

Schurmann states that because all attempts at neurosurgical treatment ultimately fail, the solution to the problem of phantom limb pain lies with the psychiatrists and psychologists. This rather narrow-minded statement is followed with a quote from Ronald Katz, an anesthesiologist who has also devoted most of his life to the study of pain, "Each physician finds what he is trained to find, and the psychiatrist will find psychologic problems in all patients. Whether or not such findings help in the treatment of the patient is another matter."<sup>9</sup>

## METHODS OF TREATMENT

### NEUROSURGERY

Since pain is associated with one or more aspects of the nervous system, surgeons for many years have been destroying different parts of the nervous system from peripheral nerve to cerebral hemisphere in an attempt to decrease phantom pain. Destruction of the nervous system has two major setbacks as a form of pain treatment; first, it provides only temporary relief of pain as it always returns; and second, this type of surgery carries the inherent risk of permanent neurological incapacity. Due to these shortcomings and to

the relatively new theories on phantom pain, treatments have been developed which are less invasive and at least as effective as surgical procedures.

### ELECTRICAL STIMULATION

The Gate theory has lead to the development of several treatments. Electrical stimulation is one such procedure which is designed to stimulate peripheral nerves lacking sensory stimuli due to the amputation. According to the Gate theory this increase in stimuli should increase the inhibitory effects of the brain thus decreasing the hyperactive neural mechanism causing pain. In the past, electrical stimulation has shown only marginal results, with most researchers achieving approximately a 50 percent success rate.

In 1977 John Miles and Sampson Lipton decided that patient selection for this form of treatment by diagnosis alone provided too unreliable a guide. They therefore devised a battery of tests which are given to each subject to determine the patients suitability for electrical stimulation treatment. The tests include: (1) pharmacological assessments to withdraw addictive drugs and determine the patients existing analgesic regime. (2) psychiatric assessment in order to determine if any psychoneurotic disturbance existed; and (3) physiological tests to determine the integrity of the sensory system.<sup>10</sup>

After assessing twenty patients, twelve were determined suitable for stimulator implant into the peripheral nerve. Results show seven obtained excellent relief of pain such that they no longer require analgesics, three patients obtained partial relief of pain and require only occasional analgesics, and two patients received no relief of pain.<sup>11</sup> The authors go on to explain that at a later time the two failures were discovered to be unsuitable after all, and should not have passed the physiological tests due to ipsilateral cord injury.

### DORSAL COLUMN STIMULATION

Dorsal column stimulation is another treatment developed since the publication of the Gate theory. It is similar to electrical stimulation except rather than stimulating the



peripheral nerve, the dorsal columns of the spinal cord are stimulated.

Nielson et al, has treated 129 patients with dorsal column stimulation. A formal study has not been published, however Nielson has published preliminary case reports on five patients who have achieved good results. These results have been successful for up to two years of follow-up, thus permitting "cautious optimism" for this form of treatment.<sup>12</sup> It is obvious that not much more can be said for dorsal column stimulation until the full results are available.

### PHARMACOLOGICAL TREATMENT

Fanciullacci et al, have been treating their patients with the drug Lysergic Acid Diethylamide (LSD-25). They base their treatment on the belief that some amputees may benefit from an increase in the neurotransmitter serotonin. Serotonin is thought to be one of the most important neurotransmitters in central modulation of pain, and there is evidence that deficient serotonin increases sensitivity to painful stimuli.<sup>13</sup> LSD-25 is known to potentiate levels of serotonin, therefore when administered to individuals deficient in serotonin and experiencing phantom limb pain, the pain should cease.

In Fanciullacci's study, seven subjects were given low doses of LSD-25 every day for eight weeks; results were based on the observation of the daily use of analgesics. Results show that in five patients LSD-25 produced improvement in pain and reduction in use of analgesics. Two of these five patients no longer require their pain medications. In the other two patients, LSD was ineffective and analgesic use remained unchanged.<sup>14</sup>

Unfortunately LSD-25, even in non-hallucinogenic doses, has side effects which include psychic reactions and perceptive distortion. It is also believed to be addictive in nature.

### BIOFEEDBACK TREATMENT

The use of biofeedback in the treatment of phantom pain is based partly on the peripheral theory and partly on the psychological

theory. Advocates feel that phantom limb pain may be the result of the anxiety—muscle tension—pain cycle. They base their treatment on the idea that amputees suffering phantom pain may have spontaneous muscular hyperactivity in their residual limbs (as a result of high anxiety levels) which are irritating the cut ends of the peripheral nerves. Biofeedback is a system by which these muscle contractions are made audible to the patient via electrodes. This feedback signal stops when an appropriate decrease in muscle tension is reached; thus the patient learns to relax his musculature and relieve pressure on the peripheral nerves.

Results of studies on the effectiveness of biofeedback in decreasing phantom limb pain are very similar to the results shown for all previously described treatments. Advocates state the reason for their small failure rate is the fact that some patients can not learn to relax, and have strong psychological needs for their pain.<sup>15</sup>

### PSYCHOLOGICAL MANAGEMENT

Pasnau and Pfefferbaum, two psychiatrists, propose a three-phased strategy in the psychological management of the amputee. Phase one is prevention. In this phase an attempt is made to address the healthy coping mechanisms in each patient. This includes thorough discussions with a psychiatrist on the fears each patient (and the patient's family) may have. Phase two is crisis intervention. Here they consider the development of pain in the postoperative period an emotional crisis. Rapid intervention is therefore required in the form of psychiatric assessments of personal strengths and assets with the goals of alleviating anxiety, reassurance, and restoring coping mechanisms. The final phase includes psychotherapy and behavioral therapy. It is their belief that many chronic pain patients use pain for secondary gain in terms of medication, disability payments, or in other ways in their family or marital relationships. These pain personalities pose extremely difficult treatment problems and therefore require behavioral or psychotherapy.<sup>16</sup>



## CONCLUSION

Electrical and dorsal column stimulation, drug treatment, biofeedback, and psychologic care are the major non-surgical forms of treatment for phantom limb pain. Because the mechanism of phantom pain is still unknown, a definitive treatment which cures all patients is not yet available. It is possible that there exists several different mechanisms, some involving the nervous system, others involving psychologic problems, and perhaps some involving both. This would explain why each treatment described totally cures some patients and yet has no effect on others. Miles and Lipton (electrical stimulation treatment) are perhaps moving toward this concept since they run each patient through a battery of pharmacological, psychological, and physiological tests to determine suitability for their form of treatment. It is the opinion of many medical authorities that when considering treatment for patients with phantom limb pain, each case should be thoroughly examined, neurologically and

psychologically, in order to determine the best course of action.

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