# Physical Therapy for a Patient with Complex Regional Pain Syndrome and History of Morton's Neuroma: A Case Report

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## ABSTRACT

**Background:** Injury to nervous tissue is the leading cause of Complex Regional Pain Syndrome (CRPS), which is a multifaceted condition affecting both the peripheral and central nervous systems. The purpose of this case report is to present a physical therapy program that helped reduce the impact of CRPS on a patient's body impairment, activity, and participation. **Description:** A 61-year-old female presented with a chief complaint of right foot pain and abnormal gait secondary to CRPS. Three months prior the patient underwent surgery for the excision of a Morton's Neuroma. Using clinical practice guidelines for orthopaedic conditions and chronic pain intervention strategies, physical therapy management was applied. **Outcomes:** After 8 weeks, significant improvements were observed in pain level and return to function. **Conclusion:** A multimodal evidence-based approach was successful in the management of a patient diagnosed with CRPS.

**Key Words:** allodynia, foot pain, hyperalgesia, manual therapy

## BACKGROUND

Complex regional pain syndrome (CRPS) is a condition that affects both the central and peripheral nervous systems with pain being the most prominent characteristic.[1,2] It often occurs after surgery, minor trauma, periods of immobilization, or cerebrovascular accidents.[1-4] Clinical features of CRPS include allodynia (pain from a non-noxious stimulus), motor disturbances, hyperalgesia (heightened sensitivity to pain), vasoconstriction, vasodilation, edema, changes in skin temperature and color, trophic changes to the skin, hair, and nails, and body perception disturbances.[1-4] It typically affects one area of the body with a glove or stocking distribution being the most common presentation.[1,3,4] The incidence of CRPS ranges 1-2 per 100,000 annually and is 3 to 4 times more likely to affect women than men.[1,2] The pathophysiology of CRPS is quite complex with disturbances and changes in the sympathetic, somatosensory, and motor nervous system.[1] Initially, the sympathetic reflexes are affected leading to increased susceptibility of hormones and neurotransmitters into blood vessels making nociceptive receptors hypersensitive.[1,4] This is thought to cause alterations in the Ph levels of tissues causing a reduction in oxygen.[1] Complex regional pain syndrome is also associated with an increase in pro-inflammatory proteins that may have a significant role in the development and maintenance in CRPS by ultimately sensitizing nerve endings.[1] The central nervous system is affected by the activation of glia cells on the spinal cord that may contribute to increased pain transmission.[1,2] Constant activity of the primary nociceptive neurons eventually may lead to reorganization of the somatosensory cortex in the brain that alters the motor cortex.[1,3] Neoplastic changes in the brain can cause difficulty performing tactile discrimination, body perception disturbances, and referred sensations.[1,3] The degree of cortical plasticity is reported to be directly related to the pain intensity of CRPS.[3]

Physical therapy has been shown to be effective in the management of CRPS to treat the impaired movement patterns, fear-avoidance behaviors, and peripheral manifestations associated with this disorder.[1,3] Recently, evidence suggests in addition to targeting the peripheral symptoms, treatments should also address the central process of CRPS through strategies such as tactile discrimination, exposure therapy, desensitization, and mirror therapy.[1,3]

A common cause of CRPS is insult to nervous tissue. The most common neuroma in the foot is an intermetatarsal neuroma, known as a Morton's neuroma. A Morton's neuroma is defined as inflammation and/or damage to the digital nerves and is typically located between the third and fourth metatarsals. This type of nerve insult can cause debilitating pain, which may require surgery to excise the neuroma. A possible complication of surgery to remove a Morton's neuroma is development of CRPS post-operatively.

Complex regional pain syndrome can affect many aspects of a person's life including their body structure and function, activity, and participation. The purpose of this case report is to present a physical therapy program that helped reduce the impact of CRPS on a patient's body impairment, activity, and participation.

## CASE DESCRIPTION

The patient was a 61-year-old female who presented to physical therapy with right foot pain. She underwent surgery for Morton's neuroma 3 months prior. Following the procedure, the patient reported her pain continued to gradually increase prompting her to return to her physician. She was diagnosed with CRPS by her medical doctor and was referred to physical therapy. She presented to the clinic wearing a soft walking boot on her right lower extremity and antalgic gait pattern; decreased stance time on the right limb due to pain. The patient was also unable to tolerate wearing socks, driving, and weight bearing for longer than 15 minutes due to pain. Other significant past medical history was a sympathetic lumbar nerve block that the patient had received one month ago for the management of CRPS without any symptom relief. The patient reported she had experienced an adverse reaction to the nerve block including feeling malaise, flushing of the facial skin, with no decrease in her pain. The patient was asked to rate her pain using the numeric pain rating scale (NPRS). The NPRS is an 11-point scale with reported validity of r = 0.87 and moderate reliability (ICC = 0.67; 0.27 to 0.84).[6] The patient rates pain on a 0-10 scale, with 0 being no pain at all and 10 being the most intense pain imaginable.[6] The patient rated her worst pain a 10/10 during any weight-bearing activities and a 7/10 at best when her foot was at rest without any tactile stimulation. At the time

of the initial evaluation, the patient reported she was experiencing a 7/10 pain.

Upon examination, her foot appeared red, shiny, and swollen (**Figure 1**). The patient reported that her foot often turned purple, white, or blanched and was unpredictable to the color change. A surgical scar was noted over the dorsal aspect of her right foot between the third and fourth metatarsals and appeared to be healing well. The active range of motion (ROM) for all the joints of the lower extremity was assessed using goniometric measurements. All joint active ROM measurements for the lower extremities were within normal limits as defined by the American Academy of Orthopedic Surgeons, except the right ankle, which lacked 10° of dorsiflexion.[7] The goniometer is reported to have good to excellent reliability in measuring ankle-foot ROM (ICC=0.58-0.97); with >0.75 interpreted as being excellent, 0.40-0.75 as fair to good, and, 0.40 as poor.[9] Passive ROM including accessory joint mobility of the right third and fourth metatarsophalangeal joints was inconclusive at the time of the evaluation due to pain and high tissue reactivity. Strength assessment of the lower extremity was performed using manual muscle testing (MMT) protocol as cited by Kendall,[11] In a systematic review on the reliability of manual muscle testing by Bohannon et al,[12] MMT reliability was stated as pairwise agreement (Kw), and ranged from 0.04 to 1.00; with 30.7% between 0.61 and 0.80 (substantial) and 41.3% between 0.81 and 1.00 (almost perfect).[12] The patient's hip and knee strength tested strong and equal bilaterally. Assessment of right ankle strength, however, was inconclusive due to increased pain with attempts to apply manual resistance to her foot.[11]

Light touch sensation testing was performed using the Ten Test for Sensation. This sensory test evaluates the patient's perception of gentle tactile stimulation of the skin area being tested, and compares it to the referenced normal area.[13] The Ten Test for Sensation has been found to have excellent inter-observer reliability with a kappa value of 1.0 ($p<0.003$) – a kappa score of 1.0 indicates perfect reliability, a score of zero indicates no reliability, and a kappa score of 0.61-0.81 indicates substantial inter-observer reliability.[14] Decreased sensation was found over the surgical incision area between the right third and fourth phalanges possibly due superficial sensory nerve damage during surgery. All other areas of the right foot demonstrated hyperalgesia/allodynia with decreased tolerance to light touch.

**Figure 1. Initial Observation of the Involved Lower Extremity**

The Lower Extremity Functional Scale (LEFS) was the patient-reported outcome measure used to objectively document the level of impairment and functional ability of the patient at initial evaluation to compare to after intervention. The LEFS is a 20-item measure where the patient is asked to rate 20 activities from 0-4 in difficulty with 0 being extreme difficulty/unable to do, and 4 being no difficulty.[15] The final score is obtained by taking the sum of all 20 items scored, with a score of 0 as the minimal possible score indicating extreme limitations, and 80 as the maximal achievable score signifying no functional limitations.[15] The LEFS has been shown to demonstrate excellent reliability (ICC=0.89-0.99) and validity showing high correlation with self-reported measures such as the WOMAC, the Knee Injury and Osteoarthritis Outcome Score function subscale, and the SF-36 physical functioning subscale ($r < 07$).[15] The patient scored a 10/80 on the LEFS at initial evaluation that signified the patient was functioning at 12.5% of maximal functioning.[15]

## EVALUATION

The American Physical Therapy Association recommends physical therapists use the International Classification of Functioning, Disability and Health (ICF) model to organize aspects of a patient's health condition to aid in decision-making, research, and policy.[16] The ICF model integrates both enablement and disablement perspectives.[16] The patient's primary impairments that were identified included right foot pain, hyperesthesia of the distal aspect of her right lower extremity, and edema of the right forefoot. Her secondary impairments consisted of decreased active ROM and weight-bearing tolerance of her right lower extremity. The primary and secondary impairments contributed to the patient's activity limitations of difficulty standing, walking, driving, and showering. Participation restrictions included an inability to participate in family outings in the community, grocery shop, or attend her weekly Pilates class. According to the Guide to Physical Therapist Practice, the patient was given a physical therapy diagnosis of right foot pain and abnormal gait secondary to her medical diagnosis of CRPS.[5]

## INTERVENTIONS

To address the identified body impairments, functional limitations, and activity limitations, the patient was seen twice a week for 8 weeks and was also given a home exercise program (HEP).[1-3] The interventions progressed from very light gentle exercises and manual techniques to more aggressive and functional interventions based on the patient's tolerance. Therapeutic exercise, gait training, joint mobilizations, desensitization, minimization of body perception disturbances, taping, massage, and patient education were implemented throughout the course of treatment. The following patient and physical therapy goals were set for 8 weeks: the patient will be able to ambulate 500 ft on uneven surfaces with a pain rating of 3/10 or less in order to travel abroad on her scheduled family vacation. The patient's prognosis was good because she was young, healthy, and motivated with no comorbidities.

### Implementation of Intervention

Each of the identified impairments was addressed with an evidence-based intervention (see **Table 1** for summary of interventions). During the first 2 weeks of physical therapy, the primary focus was on desensitization of the right lower extremity. Desensitization interventions commenced by exposing the extremity to the texture of a tissue.[3,17] The tissue was gently brushed against all surfaces of the right lower extremity in strokes starting from the most distal aspect of the phalanges proximally to the mid-tibia area. Once the texture of the tissue was easily tolerated, a new texture exposure of a soft washcloth was implemented into the plan of care.[3,17] Gradually increasing sensory stimulus has been proposed to desensitize the hypersensitive tissue by altering the central processing of the nervous system.[17] Effleurage massage was also performed to the right lower extremity at the start of the treatment sessions with

**Table 1. Intervention Progression Summary for the Patient in this Case Report**

| Interventions | Weeks 1-2 | Weeks 3-6 | Weeks 7-8 |
|---|---|---|---|
| Desensitization | Tissue >> washcloth | Crumbled paper | Mirror therapy |
| Effleurage massage | Light pressure<br><br>20 min | Moderate pressure<br>crossing midline<br>20 min | Moderate pressure<br>manual mirroring<br>20 min |
| Range of motion | Dorsiflexion/plantar flexion<br>3 x 15 reps | Dorsiflexion/plantar flexion<br>3 x 15 reps | Plantar flexion in standing<br>Dorsiflexion/plantar flexion<br>3x15 reps |
| Graded exposure therapy | Weight-shift seated<br>Anterior-posterior, lateral<br><br>5 reps each | Weight-shift standing<br>Anterior-posterior<br>>> modified tandem<br>1 x 10 reps each | Weighted plantar flexion |
| Minimization of body impairments | Refer to affected limb as "right foot"<br>Positive encouragement | Positive encouragement | Positive encouragement |
| Joint mobilization | | Plantar and dorsal glides of MTPS;<br>Grades II-IV<br><br>1 x 5 reps, 5 sec hold | Plantar and dorsal glides of MTPS;<br>Grade IV<br>Separation stretch to 3rd and 4th mets holding for 3-5 min |
| Gait training | Boot | 25 ft flat surfaces without boot | >25 ft flat surfaces without boot |
| Stretching | | Hamstrings, quadriceps, gastrocnemius<br>1 x 30 sec hold | Hamstrings, quadriceps, gastrocnemius<br>1 x 30 sec hold |
| Tape for edema | | Distal leg and dorsal foot | Distal leg and dorsal foot |
| Neural mobilization | Nerve glides<br>1 x 10 reps | Nerve glides<br>1 x 10 reps | Nerve glides<br>1 x 10 reps |
| Right left discrimination | | | Identify right and left shoe<br>on-line activity |
| Home exercise program<br>(performed daily) | Desensitization<br>ROM<br>Neural mobilization | Desensitization<br>ROM<br>Neural mobilization<br>Standing weight-shifts | Desensitization<br>Neural mobilization<br>Gait training<br>Right/left discrimination |

Abbreviations: reps, repetitions; ft, feet; sec, seconds; min, minutes; METs, metatarsals; ROM, range of motion

very light pressure to decrease edema and augment desensitization.[17,18] To improve ROM and decrease edema, the patient was instructed in active ROM exercises including supine ankle dorsiflexion and plantar flexion.[17,19] Additionally, gentle passive ROM of the right great toe was implemented to maintain mobility.

Graded exposure therapy has been shown to improve function, decrease fear-avoidance behaviors, and decrease pain-related fear in patients with CRPS.[1-3] Therefore, graded exposure therapy including weight-bearing therapeutic exercises such as seated weight shifts with feet in full contact with the ground, and slow and controlled seated right ankle plantar flexion were implemented into the treatment program.[2,3,17] The patient continued to use a soft boot during ambulation to increase weight-bearing tolerance.

Neural mobilizations were also performed as they have been shown to improve intraneural fluid dispersion, reduce intraneural edema, reverse increased immune responses, and decrease hyperalgesia following a nerve injury.[21] To perform the neural mobilizations, the patient stood with upper extremity support and her right foot placed on a platform to decrease weight bearing.[20,21] The patient was instructed to flex her right knee, hip, and spine, and then glide the nerve by moving into right dorsiflexion, knee extension, hip extension, and finally extension of the spine. The foot position was altered during the mobilization from a neutral position, into internal rotation, and then into external rotation to target the nerve glide to different lower extremity nerves.[21]

Body perception disturbances, another characteristic common to CPRS, can present in various ways including neglect of the effected limb.[3] Minimization of body perception disturbances was integrated into the plan of care by the physical therapist continuously emphasizing the labeling of the affected extremity as the "right lower extremity" and "right foot", as the patient tended to refer to her foot as "it."[3] Neglect of the involved side can be an acquired attribute of patients with CRPS. Encouraging interaction and acknowledgement of the affected body part promotes

normalization of sensory and motor responses of the affected limb as well as influences cortical mapping.[3] Pain science research involving right/left discrimination tasks has also been shown to be an effective intervention strategy in addressing body perception disturbance in chronic pain patients.[3]

In addition to the interventions provided, the patient was also given a HEP and instructed to complete daily: texture exposure using a tissue, progressing to a washcloth as tolerated, neural mobilizations, and active right ankle plantar flexion and dorsiflexion.[3,17,21] Videos demonstrating and explaining the home exercises were provided to the patient as videos have been shown to have a positive effect on the compliance of HEPs.[22]

As the patient progressed during weeks 3-6, effleurage massage continued progressing to increased manual pressure to moderate.[17,18] Minimization of body perception techniques were also introduced at this time and involved placing the patient's affected limb across midline during effleurage massage.[3,17] Patients with CRPS often demonstrate a shift in the subjective body midline. Placing the affected limb across the center of the body has been shown to positively influence the skin temperature and tactile discrimination.[17] Effleurage massage across midline was performed every treatment session during weeks 3-6.

At week 4, the patient was able to tolerate joint accessory mobility testing, which revealed hypomobility of the third and fourth metatarsophalangeal joints.[23,24] Accessory motion testing reliability of the ankle-foot has shown to vary greatly (ICC -0.67 to 0.84), with greater consistency found with more experienced clinicians.[9] Joint mobilizations of the third and fourth metatarsophalangeal joints were therefore performed into plantar and dorsal directions.[25,26] Posterior glides to the right talus was specifically incorporated to improve ankle dorsiflexion, followed by active and passive talocrual ROM.[17,19,26] Mobilization with movement has been reported to be an effective intervention to restore ROM.[27] To perform this technique, the patient stood with her right foot on a platform. She then lunged forward to provide a passive dorsiflexion stretch while the therapist simultaneously applied a posterior glide to the talus. The patient also continued to perform neural mobilizations with upper extremity support and use of a platform. Appearance of the limb was notably improved and objectified through photographs at week 4 (**Figure 2**).

**Figure 2. Observation of the Lower Extremity After 4 weeks of Physical Therapy**

During weeks 3-6 the patient also progressed to standing gait training activities with use of bilateral upper extremity support.[3,17] She slowly weight shifted in all directions and was later progressed to more challenging weight shifts in a modified tandem stance with decreased upper extremity support.[3,17]

The patient was introduced to right/left discrimination activities. Determining right from left has been shown to enhance neuroplasticity and cortical remapping that is often altered in patients with CRPS.[17] The patient enjoyed shopping online so was instructed to practice right and left discrimination when shoe shopping by identifying if the shoe that was displayed on the screen was a right or left shoe.[17] Improvements in right/left discrimination have been shown to decrease symptoms of the effected extremity.[17]

At week 6, the patient was able to walk short distances within the facility without the use of her soft boot. Taping (kinesiotape) was also added at this time to address the chronic edema using two 6-inch pieces of tape cut with 1-inch bases and 6 small strips.[28] The bases of the tape were placed on the distal aspect of the tibia with the strips making a criss-cross pattern over the dorsal aspect of the right foot. Taping has been shown to restore lymphatic circulation and reduce edema by increasing the space between the skin and the fascia, which then leads to decreased nociceptor compression and improved circulation.[28]

Stretching of the hamstrings, quadriceps, and gastrocnemius muscles was also continued to maintain tissue mobility.[29] While stretching the gastrocnemius, upper extremity support was used to adjust weight bearing through the right extremity. The patient was instructed to continue her HEP (**Table 1**), and progress her tactile exposure to crumpled tissue paper, and add weight shifts as tolerated.[3,17] Videos of the weight shifts were provided as reference on proper HEP techniques to be completed once a day. Weight shifts and stretching were also encouraged to be performed in a swimming pool to take advantage of the hydrostatic pressure and reduced weight-bearing benefits of the water.[1-3] When immersed in water, hydrostatic pressure can assist in decreasing swelling, and buoyancy may assist with reduced load on joints.[30]

Abnormal or absent sensory feedback of an extremity as displayed in CRPS may lead to cortical reorganization of the primary somatosensory and motor cortex that amplifies the pain and symptoms of the affected limb.[31] During the final 2 weeks of therapy, mirror therapy was therefore implemented to desensitize the right foot.[3] Mirror therapy is a component of the graded motor imagery approach to treating patients with chronic pain, and is considered a progression from right/left discrimination tasks. It is thought to facilitate desensitization and normalization of cortical organization, and therefore was integrated into the plan of care.[17,31] Mirroring was implemented during effleurage massage of the affected limb with the addition of a second physical therapist, who simultaneously provided moderate pressure effleurage to the unaffected limb.[17,18]

Minimization of body impairments was integrated throughout physical therapy by providing positive encouragement regarding outcomes.[3,17] Many psychological aspects associated with chronic pain influence the prognosis of CRPS. Education and positive encouragement have been reported to be crucial in the management of CRPS to decrease the perception of pain.[17]

A summary of the interventions and progressions are provided in **Table 1**.

## OUTCOMES

After 8 weeks of physical therapy, the LEFS outcome measure improved from 10/80 to 38/80. The minimal detectable change (MDC) for the LEFS is 9 points indicating the patient's level of function had significantly improved.[15] Pain levels also significantly decreased from 7-10/10 to 3-5/10 exceeding the MDC of a 2 point change.[6] Joint mobility of the metatarsophalangeal joint increased from hypomobile to normal mobility.[24] The end-feel of the joint motion was no longer limited by pain but improved to a normal capsular end-feel.[23] Right ankle dorsiflexion increased 5° allowing for an

improved gait pattern. The appearance of her foot improved as well with normal coloring, texture, and decreased edema (**Figure 3**). The patient met her activity participation goals of ambulating 300 ft on even surfaces with minimal pain and without the use of a boot, and driving for 15 minutes with no pain. The patient was also able to participate in grocery shopping and attend her vacation abroad.

**Figure 3. Observation of the Lower Extremity After 8 weeks of Physical Therapy**

## DISCUSSION

This case report supports the effectiveness of a physical therapy program in managing a patient with CRPS. The patient demonstrated progress evident by her decreased impairments, increased activity tolerance, and increased participation in activities. The LEFS was used to objectively assess the functional progress and effectiveness of the plan of care. After 8 weeks of physical therapy, the patient's LEFS score improved by 28 points indicating the level of impairment significantly decreased.[15] The patient improved from 12.5% to 35% maximal function.[15] Her primary and secondary impairments were addressed as evidenced by improved right ankle active dorsiflexion, decreased tactile sensitivity, decreased pain, improved joint mobility, and decreased edema. Her activity tolerance increased with improved ability to ambulate, drive, and shower. She was also able to participate in more community outings and embark on a family vacation. Although the outcomes are likely due to the physical therapy interventions and are supported by literature, alternative explanations for the results must be considered.[1-4] The patient had received a sympathetic lumbar nerve block 4 weeks prior to beginning therapy that may have also contributed to the patient's outcomes. However, due to the lack in symptom change post injection, this is not likely the reason for improvement.

Overall, the outcomes of this case report are consistent with previous research; CRPS may persist for long durations, but by addressing the peripheral manifestations and central impairments, physical therapy can be effective in treating this chronic pain patient population.[1]

Limitations of this case report include the lack of objective documentation of some measurements. Edema of the patient's forefoot was not measured using circumferential measurement or water displacement.[32] Water displacement and circumferential measurements are reported to have excellent reliability in measuring edema[32] (ICC=0.93-0.96). The periodic measurements of the patient's right lower extremity swelling would have validated the significance of the change in swelling over the course of treatment in addition to therapist observation. Two-point discrimination was not tested. Two-point discrimination is often impaired in patients with CRPS and sensory discrimination training has been shown to decrease pain.[3] The evaluation of two-point discrimination would have provided more objective information on the effectiveness of interventions.[3]

Finally, additional interventions such as virtual reality and prism glasses have been reported to be effective in managing CRPS but were not used throughout treatment due to lack of resources, however, may have been beneficial.[3] Virtual reality uses technology to display images of the affected extremity altering its appearance and state.[3] Virtual reality has been reported to reduce activity of the caudal anterior cingulate cortex, thalamus, insula, and the somatosensory areas of the brain that function to localize pain and register pain intensity.[3] Prism glasses invert the image of the extremities making it appear to the patient that the unaffected limb is now on the side of the affected limb.[3] This has been shown to promote neuroplasticity, decrease pain, and therefore could have augmented the patient's rehabilitation program.

## CONCLUSION

Chronic pain is challenging to treat and additional research is needed to optimize patient outcomes. This case report provides an example of an evidence-based physical therapy program that was effective in decreasing the impact CRPS had on a patient's body structure, activity tolerance, and participation following surgery for Morton's neuroma.

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