

A clinical framework for understanding & treating Complex Regional Pain Syndrome based on clinical reasoning.

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Currently the International Association for the Study of Pain (IASP) has defined CRPS I criteria to include pain that is disproportionate to the inciting event, sensory disturbances such as allodynia/ hyperalgesia, autonomic dysfunction, and motor dysfunction that usually occurs after trauma that is frequently trivial and generally expressed in an extremity.⁶³ Furthermore, other authors have coined the term "Peripheral Nerve Sensitization (PNS)" as being "Sensitization arising from nerve trunk inflammation causing increased axonal mechanosensitivity with absent significant denervation."^{13,27-29,52}

Our model of treatment differs from what is currently utilized in that it revolves around *clinical reasoning* instead of protocol based intervention. This form of care for CRPS patients involves recognizing patterns, generating clinical hypotheses, clinical testing and treating, analysis of the test result with re-examination, and a revision of the treatment plan²⁵. We are introducing a new paradigm, that the spine is the primary pain generator in all CRPS cases. An extensive literature review has shown that this idea has not been considered previously, as will be shown below.

CRPS has three primary components:

- 1) Injury to a lower extremity (LE-CRPS) or upper extremity (UE-CRPS)
- 2) Thoracolumbar spine problem or (LE-CRPS) cervicothoracic spine nerve problem (UE-CRPS), either of which the patient is generally unaware of.
- 3) Brain contribution. This takes three forms. Firstly, fight/flight/Freeze responses produce central sensitization. Secondly, poor decision making results in unintentionally worsening the condition. Lastly, there is overprotective patterning contributing to fear of movement behavior. This leads to overprotective patterning and fear of movement behavior.

A peripheral injury, a spine problem, a brain problem. In case we have treated CRPS, all have had spinal components. These components can sometime develop as a result of the extremity injury, or sometimes be present prior to the extremity injury. Addressing this central component we feel hinges on success or failure of the case. This has been previously coined as "Specific Signs of Local Dysfunction"¹⁸ A patient who is willing to learn about how to treat these above 3 components will improve. Our experience is a patient who is unwilling will not. "Change" will be required on their part of caring for their body, much more than just the peripheral area they may think is the sole problem. Therefore education to explain the link between spine and extremity to the patient is a necessity. It is also important to review that many patients have had MRI imaging and been told they have negative findings. The literature shows that upwards of 80% of all low back pain cases have no positive imaging findings. It is faulty logic to conclude that negative imaging equals no spine contribution.

CRPS is a painful condition that affects the upper or lower extremity, characterized by severe, out of proportion pain often described as "burning," marked limitation in function, altered sensation (i.e. hypersensitivity or hyposensitivity), gait dysfunction in the lower extremity, and altered movement patterns in the upper extremity. Anxiety is also often associated with CRPS, as is irrational overprotective patterning^{46,50,55,58, 63}.

Take, for instance, a patient with one of the most common orthopedic injuries in the world: the ankle sprain. There are two treatment paths in an ankle sprain case. Either recovery in 3-4 weeks with

rehabilitation provided in an optimal manner, or many clinical mistakes made by either the patient or the healthcare provider, causing a simple condition to worsen and become more complicated over time.

In the case of an optimal recovery:

- 1) Gait pattern is normalized with specific gait training and appropriate weight bearing status. Aids such as an aircast, ankle brace, or crutches may be used.
- 2) The components of R.I.C.E. (rest, ice, compression, elevation) are diligently adhered to. This requires educating the patient, so that they do not inadvertently complicate their own recovery.
- 3) ROM (range of motion), strength, proprioception, and weight bearing are regained and progress in a pain-free manner.
- 4) Sport specific skill exercises (multidirectional movement, acceleration, deceleration, etc.) are reanalyzed before reentry into athletics.

In the case of CRPS development:

- 1) **Weight bearing sensitivity:** Patient is allowed to continue to limp, or uses crutches inappropriately with excessive weight bearing and/or abnormal lower quarter kinematics. This produces abnormal gait, which leads to muscle inhibition, abnormal tissue loading, and then pain. Changes in the brain via cortical remapping then take place, changing to an abnormal motor program³¹.
- 2) **Ankle Weakness Becomes Worse:** Unprotected weight bearing causes further damage to the ankle, as well as more swelling and pain. The patient begins to feel anxious, so they take OTC pain medication. This masks the pain, which is normal and needed to communicate to the brain that the injury has not healed.
- 3) **Protective Patterning:** The patient starts unconsciously protecting their ankle by shifting weight away from their injured side throughout daily transitions (standing up, getting into bed, etc.) using their entire lower extremity (ankle, knee, hip, lumbar spine) to do so. If this state is prolonged over the course of six weeks, this protection can lead to transformation of flexion withdrawal reflex from high threshold phasic to low threshold tonic.⁶⁴ Overprotective guarding of knee/hip/lumbar begins, with increased muscle activation either ipsilaterally or bilaterally^{31,48,54}.
- 4) **Altered Neuro Dynamics:** This effectively refers to nerve irritability, as the active slide and glide of the nerve is inhibited by adhesion or the presence of a pseudoneuroma. This prevents "proper venous removal of toxins and changes in transport of exudate".^{3,33,35,37} The nerve is forced to dump waste using axoplasmic flow and these waste products sensitize distal innervation sites.^{8,9,11,20,23,33,34} Clinical testing has existed for over 50 years: Lasague and Slump test^{36,38,61} for the sciatic nerve, and Upper Limb Tension Tests for the Brachial Plexus (ULTT).^{16,17,27,28,29} Imagine instead of normal dental floss sliding and gliding in a straw, that you put c-clamps along the straw every inch. This is what protective guarding does to a nerve, and the beginnings of nerve irritability begin. Both the Lasague and Modified Slump tests are appropriate clinical tests for this occurrence.
- 5) **Neurochemical changes in the Brain:** Research has identified neurochemical changes in the brain at this stage, which further change nerve irritability, noting physiological changes at the dorsal root ganglion (DRG) now causing sensory changes in the ankle supplied by the L4-5 nerve roots.¹¹
- 6) **Cognitive Changes in the Brain:** Anxiety over the injury ("I am not getting better) causes increased stress, causing increased cortisol production, which we know research has validated causes healing of tissue to be compromised. If not recognized early the patient will then start to catastrophize ("I am going to be like this forever") now interfering with logical thinking, difficulty concentrating, and irrational behavior.⁵⁹

- 7) **Thoracic Spine Involvement:** Overprotective guarding progresses to the thoracic spine involving the sympathetic nervous system via irritability of the sympathetic chain.^{45,47} Breath holding patterns, part of protective patterning, also can affect the thoracic cage, further limiting mobility in addition to a vascular effect on venous return. The thoracic effects of the patient's compensation causes the nerve plexus to behave abnormally, facilitating nerve sensitivity. The clinician should consider manual and manipulative therapy of the thoracic spine (thoracolumbar or cervicothoracic) as part of treatment of the central pain generator.⁷

- 8) **Pain Pressure Thresholds Change:** Central sensitization of the nervous system takes place, whereby tissues become hypersensitive either in the upper or lower quarter involved, measured by Pressure Algometer (see below)²⁷⁻²⁹

These two comparative scenarios show how a relatively simple injury can become much more complex, as the spine and brain become problematic as well as the original injury. The examination of a patient who is suspected to have developed CRPS should progress as follows:

- 1.) **Determine if the four cardinal signs are present:** 1) Allodynia (i.e. pain out of proportion to the original problem) 2) pitting edema 3) trophic changes such as red shiny skin and/or hair loss in area 4) vascular changes including color & temperature changes (red, blue or mottled).⁵⁸
- 2.) **Complete a neurological scan: checkin deep tendon reflexes, sensation, motor testing** (myotomal examination).
- 3.) **Test the patient's spinal range of motion.** A decreased ROM suggests a lumbar component. Total ROM, however, does not automatically mean there is no spinal component. Clinicians should go further, testing for joint mobilization as well as sciatic nerve.
- 4.) **Nerve Provocation Testing.** Some clinicians may be familiar with Sciatic nerve provocation testing, specifically Lasague and Slump testing. Many clinicians are unfamiliar with brachial plexus provocation testing, also known as ULTT (Upper Limb Tension Testing). Some health care providers follow a medical model that if the MRI of the brain, then the brain is normal. However, post mortem studies will show anatomical problems we cannot see on MRI. Additionally, some follow the philosophy that if EMG studies are normal, then there is no nerve contribution to the case. The creators of the nerve provocation testing would disagree. If neurogenic symptoms can be reproduced with these specific provocation tests, then a nerve problem exists. In our discussion today, this would fall into CRPS I. If the nerve provocation testing are so "profound" as to have positive EMG testing, then this diagnostic criteria would warrant CRPS II. The authors of nerve provocation testing would argue that EMG testing is not sensitive enough to rule out a nerve problem completely.^{26,60,66} Therefore it is most critical that a thorough clinical examination be performed.
- 5.) **Spine Directional Preference Testing.** The McKenzie Method has contributed to the research for classification of neurogenic pain for spine disorders for the past 60 years.³⁹⁻⁴⁴ There has not been, to the authors literature review, any prior publication of the use of the McKenzie Method and/or directional preference with CRPS cases. That being said, we find that this method of examination is a critical component to both diagnose and treatment of this condition. The McKenzie Method stresses diagnosis of the spine, classifying conditions into three categories: postural, dysfunction, and derangement syndromes. The purpose of this part of the examination is to identify an effect on peripheral pain with clinical testing of the spine. The goal should be to be able to either improve the peripheral pain with some form of mechanical treatment to the spine, whether it be from manual therapy (PT generated force to the spine in a certain direction) or the patient able to change their peripheral pain in a similar fashion on their own.
- 6.) **Pain Pressure Thresholds changes:** Central sensitization of the nervous system takes place,

whereby tissues become hypersensitive either in the upper or lower quarter involved, measured by Pressure Algometer (see below)²⁷⁻²⁹ The authors have found the pinwheel and kleenex to be the most consistent, non-threatening measures of sensitivity. Clinicians should exercise caution when choosing to use an Algometer with CRPS patients, since the patient could potentially feel threatened, triggering a fight or flight response. Causing psychological distress on the initial visit could be detrimental to the patient/clinician relationship that is being established.

7.)

Pressure Algometer:



Neurological Pinwheel:



Laser Temperature Sensor:



8.) Identify Vascular Changes. Vascular changes can be easily identified by reports of patient or family seeing color changes in the limb, although these reported symptoms may never be actually seen by the clinician. Temperature changes are more frequent in early phase CRPS and can easily be identified with surface temperature gage as shown above, noting temperature differences of 3 degrees F is significant between the limbs.⁶² The clinician should not assume they can detect 3 degrees difference with their own human hand, but use a temperature gauge. Only when CRPS has advanced in severity will profound changes such as pitting edema and/or digits that are sausage in appearance be observed.

The Treatment Plan

If a CRPS case is caught early and effective treatment to the above four “cardinal signs” is addressed by a trained physical therapist in under a year, a full recovery is possible. If the condition is not treated until after one year, the patient’s prognosis is less likely to have a full recovery, due to the likelihood of permanent nerve damage and/or neurophysiological changes in the brain. This is based on our empirical clinical experience of working with CRPS patients since 1990, in addition to research data. (reference: Stralka). The following framework emphasizes clinical reasoning as opposed to a protocol-based form of intervention selection.

As an important side note, the use of modalities with CRPS patients should be discouraged. It is our experience that ice is not tolerated due to hypersensitivity (worsening pain), and heat interventions cause edema to worsen, as does contrast bath therapy, due to vasodilation. In certain cases, compression wrapping may be helpful, but hypersensitivity is a limiting factor for this as well. TENS (transcutaneous electrical stimulation) used over the spinal level contributing to peripheral pain should be used as a last resort. TENS in and of itself does not solve the problem but can temporarily modulate neurogenic pain and/or additionally have settings to produce beta endorphine/enkephaline effect.¹⁰ Using a TENS unit on the spine would only be helpful for decreasing pain temporarily for a patient, so that their level of fear can

decrease enough to have a productive visit, engaging the patient in more interactive activities, rather than passive intervention only, such as modality use.

Week/Phase 1: A clinical goal of improving continuous pain to intermittent is a very important goal. Literally teaching the patient how to “turn off pain” is focused upon. This will be achieved with combination of Manual therapy and/or McKenzie Method targeting at the spine, targeting which we will call the "central pain generator". Cases have an extreme variability patient to patient, noting some will respond to McKenzie Method techniques, others, manual and manipulative procedures ⁴, and yet others will require a combination. The clinician will need to become trained in both the McKenzie Method and neuro-mobilization techniques, as no two patient cases are alike. Education programs are offered by the McKenzie Institute International, in addition to programs related to the original works Robert Elvey ¹⁴⁻¹⁸, Michael Shacklock ⁵³, and David Butler ⁵. If no directional preference is obtained then manual therapy to the thoraco/lumbar spine for CRPS-LE or cervico/thoracic spine for CRPS-UE is advised, immediately followed by motor control activity in the same direction as the manual therapy. Decrease of neurogenic symptoms has been shown to be valid in the research. ⁴⁹ If the patient presents with significant overprotective guarding, starting an aquatic based program is advised for a period of 2-4 weeks, emphasizing movement of both spine and extremity, but yet in a gravity suppressed environment. The clinician needs to be mindful of when overprotective guarding will present a barrier to having manual therapy or other land-based procedures from being effective. In certain cases, these interventions will make the patient worse due to unconsciously fighting movement-based treatment with overprotective patterning.

In this case, the patient's peripheral pain complaint, when having the spine treated on the treatment table will start to change, either in location or intensity. The concept that knee pain could be abolished or changed with any type of spine treatment, for many clinicians will be a new concept. The clinical goal within the visit would be to have no pain at rest or in supine (i.e. non-weight bearing), therefore the spine (including sympathetics, namely the thoracic spine) should be treated first, then when this is achieved, starting to address the peripheral component next. Their home program should logically emphasize the same movements with the goal of having the patient in control of their pain. It is again important to stress to the patient that they understand they have more than one pain generator: both a central (i.e. spine) and peripheral (i.e., ankle or knee) contributor. Emphasis on optimal posture in sitting, standing and sleeping should be a part of this initial phase, as should spinal ROM. Consideration should be given to dispensing a small neck or back book or other small neuroscience patient education material with an assigned reading, on the initial visit with follow up to confirm that learning has occurred.

Gait: walking without pain with assistive device, graduated weight bearing program explained. Pain education initiated, including possible Fear of Movement questionnaire given. Patient frequency should be seen daily until this achieved. Generally achieved in 3-5 visits if patient following directions). Patients are advised to start with 10 minute maximum standing/walking times with assistive device. Excessive standing or weight bearing times will affect CRPS-LE adversely. Aquatic therapy should be considered at this stage as a means to progress the patient at a faster rate, due to the anti-gravity effects of buoyancy, and/or if no progress is made in the first 1-2 visits.

Transfers: emphasis on sit to stand being normal, equal 50-50 weight bearing on each lower extremity, using a mirror to help patient recognize abnormal movement patterns (avoidance strategies) using visual feedback.

Breathing/Relaxation: many patients will have patterns of breath holding they are completely unaware of, as an unconscious coping strategy for pain. This must be addressed by the treating clinician with two-fold goals.

- 1.) patient recognition of abnormal behavior as a coping skill that is not helpful, but harmful,
- 2.) patient able to start breathing/relaxation exercises towards having normal function in this area.

Week/Phase 2: Nerve provocation testing (nerve irritability) is expected to improve as well as surface temperature discrepancies. Gait and weight bearing status should progress gradually, as peripheral joint ROM and function would suggest is reasonable. Any therapeutic interventions should start as non-weight bearing (NWB) which includes aquatic therapy. The clinician should continue to reinforce patient accountability, emphasizing the concepts of “cause and effect” and how this relates to their pain status. If the patient exhibits any lumbar spine extension directional preference then the stationary bike should not be utilized, as this type of prolonged sitting will increase sciatic nerve irritability. Recognize that a pattern of no spinal directional preference at this stage can easily change to having a directional preference as the patient improves.

Week/Phase 3: Weight bearing should be progressed as tolerated, and standing/walking time should be limited to a maximum of 15-20 minutes. Setbacks/regression is an expected component of the first three phases, as the patient is learning their physical limits and identifying triggers of pain. Examples of this include sitting too long (spinal contributor), standing too long, being too physically active and abnormal postural strain. It is critical that the patient show mastery in different weight shift activities (such as those pictured below) prior to the progression from two crutches to single crutch gait..

1. Side to side weight shift
2. Heel toe weight shift (Loading Response phase of gait)
3. Step-weight shift

Week/Phase 4: The patient will progress to closed kinetic chain activities with dynamic proprioception emphasis. Not only should normal movement patterns be relearned and practiced, but the patient should also start to feel target muscles activating. It is highly important that the clinician ask for feedback on what the patient is feeling, as he/she may not feel any muscle contraction at all, due to poor motor recruitment and/or part of a mental block due to chronic pain states. The clinician will need to highlight patience and perseverance with motor learning concepts, and prioritize the patient *feeling* the targeted muscles that are being focused on with motor control activities as important goal. At this phase, spine examination procedures (i.e. Peripheral Nerve Examination, McKenzie Spine examination) should be near normal. Cases that have had CPRS for over one year may indeed never reach this level.

Week/Phase 5: Once closed kinetic chain function has reached a level of mastery, plyometrics can be initiated as tolerated. The emphasis here is on eliminating avoidance strategies, and maximizing proprioception awareness and normal kinesthesia. Beginning examples of this would include a lateral hop and easy skipping activities (for lower extremity cases) and the progression of wall push-ups to knee push-ups or normal push-ups, and eventually weight training activities.

PSYCH: Identification of anger, depression or anxiety are all yellow psychosocial flags for a negative prognosis and will make progress of any kind more difficult. ^{19,22,24,30,59}To improve the odds of success, a psych referral is a necessity, or the physical therapist will need to address as much of the psych issue as possible. This situation causes more clinical challenges, as it takes away from “physical” treatment. Assigned readings should be encouraged, and minimized dialogue is advised, as more speaking and discussion during the session increases the likelihood of triggering an emotional response, which can increase pain status. It is extremely important that a multidisciplinary medical team be utilized in these more complicated cases that are not responding in a timely fashion.

IMAGING: MRI is usually not helpful in CRPS cases, due to relevant findings rarely being identified through this method. Often findings that are identified produced fear and anxiety in the patient which can introduce additional obstacles to overcome.

Prevention For Surgeons, Physicians and Physical Therapists

Over the past 25 years, there has been a shift from casting immobilization with the use of crutches to the use of splints and boot immobilizers with no crutches. This is due to the recognition of morbid deficits casting can cause such as capsulitis and muscle atrophy. As CRPS is so often associated with onset post immobilization, however, the authors feel strongly that casting still has its place and should be utilized instead of a splint or boot, purely due to patient compliance. The authors have seen full weight bearing in boot immobilizers as a common initial onset history of CRPS-LE. It is critical that patients be informed that increased pain with immobilization should be reported to their physician promptly, as this will only worsen if left untreated. Pain worsening with immobilization should be considered suspect CRPS in most cases.

DIFFERENTIAL DIAGNOSIS

Patients are sometimes misdiagnosed with CRPS. Examples of this would be some cases of Diabetic Neuropathy or Post-Herpetic Neuropathy, but the highlighting difference between these and CRPS is the hypoesthesia with pinwheel testing and a positive glucose lab in the case of Diabetes. This could easily be overlooked when the patient's pain is out of proportion, trophic changes and pitting edema is evident, and no prior diabetic history is documented. Any physical therapy intervention aimed at treating CRPS will be largely ineffective, however, as the diabetes is driving the neurogenic pain in this case. We have seen such cases occur. It will be up to the physical therapist to communicate these findings appropriately and recommend specific testing to be performed by the patient's PCP. Another example is lumbar radiculopathy (LR), which is very similar to CRPS in that both will likely have positive nerve provocation testing if pain (instead of dysesthesia) is seen, and McKenzie Method examination of repeated spinal movements will often result in positive findings. The difference, however, is that LR does not result in pitting edema, pain out of proportion, abnormal PPT measurements, or surface temperature changes, while CRPS can result in all of these.

CASE STUDY 1

A ten year old female presented with posterior and lateral left ankle pain, denying any trauma history. Pain was reproduced with any weight bearing activity. The initial treatment by pediatrician included Plain film radiography (negative) and a recommendation for rest, ice, compression and elevation. The patient took seven days off of athletics with no improvements and decided to pursue physical therapy. Patient was seen by a PT who is a board certified Orthopedic Clinical Specialist (OCS). Exam findings included antalgic gait with decreased stance time, left ROM deficit and avoidance behavior with sit to stand transfers and any weight bearing activities. See tables below for further details.

Ankle - Passive Range of Motion

Motion	Right	Left
Dorsiflexion	WNL Degrees	0 degrees
Plantar-Flexion	WNL Degrees	35 degrees
Inversion	WNL Degrees	WNL Degrees
Eversion	WNL Degrees	WNL Degrees

Ankle - Muscle Testing

Measurement	Right Strength	Left Strength
Ankle Dorsiflexion	5/5	5/5
Plantar flexion	5/5	3+/5 *pain
Eversion	5/5	4-/5 *pain
Inversion	5/5	5/5

Knee	Full	Full
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Ankle - Special Testing

Special Test	Right	Left
Anterior Drawer	Negative	Negative
Anterior Talofibular Ligament Stress test	Negative	Positive
Distal Tibia/Fibula Stress test	Negative	Negative
Deltoid ligament stress test	Negative	Negative
Tinel's Sign at the Ankle	Negative	Negative

Ankle - Joint Mobility

Joint	End-Feel
Subtalar Joint	Hypomobile bilateral
Talocrual Joint	WNL bilateral

Palpation: Tenderness over (L) Achilles tendon, medial and lateral gastrocnemius muscles and ATFL area.

Initial Assessment by this clinician was Achilles tendonitis and ankle sprain. Initial plan of care included gait retraining with crutches, ankle range of motion and pain-free strengthening and putting soccer/athletics on temporary hold. After three visits, patient failed to make any improvement in symptoms with traditional ankle rehabilitation. The primary PT referred the patient to the primary author(JG) for consultation on fourth visit.

Reassessment revealed the following impairment list:

- 1) Pain out of proportion
- 2) Overprotective/high anxiety over problem
- 3) (L) sciatic nerve provocation testing and positive Lumbar McKenzie exam
- 4) Weakness (L) lumbar, hip, knee, ankle manual muscle testing
- 5) Sensation deficit: hypersensitive
- 6) Gait dysfunction: antalgic gait/painful weight bearing

Revised PT diagnoses: Early phase CRPS left ankle.

Change in plan of care consisted of removal of crutches and placed on a scooter to enforce non-weight bearing due to patient being threatened by any pain. Mother was given an educational handout on pain and educated on understanding cause and effect. Specifically cause and effect on how certain movements that cause an increase in pain should be avoided in order to not make pain worse. Started treatment with lumbar mobilizations to normalize left sciatic nerve then treat other impairments secondarily. Updated assessment was sent to referring physician who agreed with this diagnosis.

Visit Five: Transition to a scooter for ambulation, spinal mobilization, spine ROM exercise resulted in normalizing sciatic nerve provocation testing (i.e. Lasague and Slump test). Focused on spinal mobilization and stretching resulted in improvements of slump test and straight leg raise. Patient appeared less anxious and preoccupied with her pain.

Visits Six and Seven: Lumbar ROM and core motor control activities yielded achieving goals for the four major components of CRPS. Increased awareness of body position and breath holding. Partial weight bearing with crutches. Awareness of protective behaviors. Able to reduce and improve nerve symptoms in left leg with neurodynamic mobilizations.

By visit nine, she was able to control pain and remain comfortable using crutches PWB. McKenzie exam of the lumbar spine were no longer provocative, and left sciatic nerve mobility improved with decreased pain provocation. Patient was able to engage in NWB aerobic exercise such as the stationary bike and rowing ergometer without complaint. The most important factor was that she was able to control her pain

using the crutches and throughout the home exercise program. Plan of care included: McKenzie Method of the lumbar spine, sciatic nerve neuromobilization, pain/CRPS education, relaxation training, body awareness training, importance of following directions, gait training with graduated weight bearing program, manual therapy, proprioception training, NWB aerobic activity and a home program.

At discharge, patient reported full recovery. She was consistent with home exercises and gradually increased activity to playing basketball. Objectively, straight leg raise, slump, pinwheel sensation, lumbar spine ROM were all normal. Hip, knee and ankle manual muscle testing 5/5 and ROM were all normal. Patient had started plyometric and running drills. All goals were met and patient was discharged with a home exercise program and encouraged to gradually return to basketball. She was advised to contact physical therapist or MD immediately if there is any return of symptoms.

Case Study 2:

Thirteen year old female presented with a 13 month history of left ankle pain. There was no mechanism of injury except for left ankle swelling after a softball practice. Initial treatment included icing ankle and a visit to the local pediatrician. Radiographs were performed and mother reports they were “questionable for a fracture”. Symptoms worsened over 1 month, which resulted in a referral to a local orthopedic physician. New radiographs were interpreted as a stress fracture; a walking boot was started for two weeks with no change in symptoms. She was referred to physical therapy with the diagnosis of CRPS. Primary author (JG) evaluated patient.

Subjective findings included VAS pain 7/10 and Functional index score 86/100% where sleep disruption due to pain, prolonged pain with standing, and pain with sports being the primary impairments.

Objective findings revealed the following

Circle around left ankle on the pain diagram. Nothing else was indicated that was painful.

Observation: No swelling or bruising. Antalgic gait for left lower extremity. Both mother and patient recognized this, with reported ankle pain with walking. Neurological exam was positive for left patellar DTR hyperreflexia and left myotome loss L2-S1 that was graded 2+/5 manual muscle test.

Ankle - Passive Range of Motion

Motion	Right	Left
Dorsiflexion	25 degrees	-2 degrees
Plantar-Flexion	83 degrees	47 degrees
Inversion/Adduction	51 degrees	10 degrees
Eversion/Abduction	23 degrees	3 degrees

Ankle - Muscle Testing

Measurement	Right Strength	Left Strength
Peroneals	5/5	2+/5
Posterior tibialis	5/5	2+/5
Anterior tibialis	5/5	2+/5
Gastrocnemius	5/5	2+/5

L-Spine - Active Range of Motion

Motion	AROM
Flexion	100%
Extension	50%*
Sidebending Right	50%
Sidebending Left	50%

L-Spine - Special Tests

Special Test	Right	Left
FABER	Negative	Negative
Lasague	Negative SLR 75 degrees	(+) 30 degrees SLR
Slump Test (Lumbar)	Positive	Positive (worst)

Additional findings were abnormal walking gait, left ankle ROM loss MARKED, weakness in left ankle, left

knee, left hip and bilateral lumbar extensor weakness, positive left sciatic nerve provocation testing. What made this case unique is the patient only reported pain in the ankle. As clinical examination reproduced low back pain, left hip pain, left thigh pain, left leg pain, the author asked her to re-draw her pain diagram "honestly" and she shaded in pain over the entire half of her lower body. Further questioning the patient revealed that the patient had indeed been complaining of pain beyond the ankle but had not been communicating this to physicians on previous occasions.

PT diagnosis: CRPS left ankle.

This patient was seen 6 visits over 8 day period, with 3 additional visits over the next 15 days to achieve a 100% recovery (total 9 visits over 3 week period of time)

Visit 1-2: Emphasis on TDWB crutch gait, with emphasis on normal gait pattern including L1-5 neuromobilization w/ sciatic nerve on tension. Additional focus on education on seated posture, neuroscience literature on neuropathic pain and how spine relates to producing sciatica. No focus on ankle as any attempt produces increased pain.

Visit 3: Left ankle pain improving (note with no actual treatment of ankle) but only with spine treatment and gait training TDWB and common-sense approach of not doing activities she is not ready for. Able to have 100% no pain with TDWB; patient was putting excessive weight through (L) lower extremity. Addressed with patient awareness/ongoing gait training.

Visit 4: Only pain was (L) sciatic pain while sitting on a bench. Patient precautions included sitting with optimal lumbar support and avoiding situations such as sitting on stools or benches, where no support was available. Refraining from being in a recliner was also discussed as this would produce adverse neural tension. Manual therapy included mobilization and muscle energy technique to L1-5 left facet side bending left/extension. Up to this point, no directional preference had been noted in terms of a pain pattern relating to spinal movement testing. Post mobilization, retesting demonstrated an extension directional preference which allowed pain to be 100% abolished during this treatment session. As pain was now controlled, weight shift activities stressing the ankle and lower kinematic chain was able to be initiated without pain response. Different aspects of gait per Rancho Los Amigos Gait, AROM ankle exercises were emphasized. Activities also included weight shift exercises as noted in images listed previously.

Visit 5: Pool therapy program was started and tolerated without pain, however patient failed to follow through.

Visit 6: Progressed gait from two to one crutch and progressed from weight shift activities to dynamic proprioception activities with an emphasis on trunk/lower kinematic alignment.

Visit 7-8: Progressed gait to no assistive device, sciatic nerve testing became negative, including all muscle testing returning to 5/5 and ankle ROM returning to normal except for right dorsiflexion 30 degrees as opposed to left dorsiflexion at 20 degrees. Progressed to agility skills which were easy and pain free.

Visit 9: Patient rates herself 100% recovered. Treadmill running test at 6 minutes 5.2 mph pain free. One month checkup following this revealed patient continued to rate herself at 100% even after adding softball activities back in.

ALTERNATIVE METHODS

Certain drugs have been observed to be helpful in moving patients down the road of recovery in CRPS cases. The use of gabapentin type drugs, such as Neurontin or Lyrica, help to dampen pain input.¹ Recent research into pain or anxiety caused insomnia due to neuropathic pain finds up to a 50% overall pain hypersensitivity.^{2,32} Discussion of sleep hygiene and the possible use of sleep medication to boost central serotonin levels can be extremely helpful in patient's overall treatment scheme.^{51,56,57} Specific nerve root or sympathetic blocks may be used to break pain cycles and to "improve intraneural tissue

metabolism and promote the washout of inflammatory substances” in CRPS patients that are not responding to conservative care. ^{1,12,21,65}

Cases of CRPS that are not solved with physical therapy will possibly be referred to physicians who may suggest surgically implanted morphine pumps or electrical spine implant stimulators to help manage pain long term. Every effort, however, should be employed to avoid this line of care, as this is the final result of the worst-case scenario. It should be noted that opiate use in the United States for non-terminal patient cases is only licensed in twenty states, and the rest of the world’s use of opiate class drugs is about 6% compared with 94% in the U.S..⁶ Furthermore, the patient with CRPS who pursues the use of opiates will gradually have to take a higher and higher dose, noting that opiate class drugs have a no-dose ceiling.⁶

CONCLUSION:

It is the authors’ observation and clinical interpretation that CRPS develops out of a simple peripheral injury that gradually worsens over time due to unintentional incorrect choices either by the patient and/or the clinician. A patient who reacts with anxiety and fear responses is associated with the development of CRPS in most cases. If a patient has CRPS for over one year, the neurophysiological changes have the potential to become permanent, or at the very least, much more difficult to reverse. This is based on our empirical clinical experience working with CRPS patients since 1990, in addition to research data. ⁵⁵

In the authors’ experience, full recovery using this clinical framework is possible if CRPS is identified prior to the one year mark, while only partial recovery is more likely in cases identified after one year. It should be noted, however, that the authors have had full recoveries in rare cases that have extended over two years. Correct diagnosis is critical, as a misdiagnosis (i.e. treating a patient who has CRPS as if they only have an ankle sprain) will waste valuable time, which could make the problem untreatable.

Furthermore, if a patient fails to demonstrate progress in four to six weeks with this clinical framework, they should consider consultation with a physical therapist who is more familiar with successful outcomes with CRPS. In extreme cases, a multidisciplinary team may be helpful or even necessary. Regardless, positive relationships within the scope of health care providers is recommended, as open communication lines will improve patient care.

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