Case Report

Treatment of a patient with post-natal chronic calf pain utilizing instrument-assisted soft tissue mobilization: a case study

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Musculoskeletal pain is commonly reported by pre- and postnatal women, with the most common complaint being low back pain. However, lower leg pain is also frequently reported by women particularly in the third trimester. The purpose of the case study is to illustrate how instrument-assisted soft tissue mobilization (ISTM) can be used to treat a patient with a 2-year history of chronic calf pain. The subject was a 35-year-old female who developed calf pain during the last trimester of her pregnancy following severe lower leg edema. The calf pain was present for the 2 years following delivery and was described as a dull ache, typically aggravated by direct pressure on the calf, prolonged standing, and stairs. An X-ray, magnetic resonance imaging (MRI) with contrast, and ultrasound Doppler study prior to referral ruled out tumors, vascular, lymphatic, or skeletal bone abnormalities. However, her MRI did show a dense superficial venous tissue asymmetry in the same location of her symptoms. Impairments were minimal; the only asymmetrical objective findings were calf length, strength, and soft tissue restrictions detected on palpation. After nine treatments incorporating an ISTM approach, soft tissue mobility, pain, calf strength, and lower extremity functional scale score all improved and her symptoms were abolished.

Keywords: Manual therapy, Massage, Instrument-assisted soft tissue mobilization, Chronic pain, Postnatal

Background/Purpose

Musculoskeletal pain is often reported by women in their prenatal and postnatal periods, with the most common complaint being low back or pelvic pain.¹ Several investigators have stated a low back pain incidence of 70–77% during the prenatal period,^{1–3} and 40–45% in the postpartum period.^{1,4,5} Other musculoskeletal sites of pain include the upper and lower extremities with conditions such as carpal tunnel syndrome, de Quervain's tenosynovitis, and various painful hip conditions.^{3,6} Non-specific lower leg pain is another common symptom reported by many women during their pregnancy; Vullo *et al.*⁷ cited an incidence of leg and foot pain of 50% in the prenatal period. Non-specific calf pain is the presence of pain in the calf without a specific medical diagnosis. Specific calf pain would include conditions such as varicose veins, which do affect 40% of pregnant women.⁸ Despite the prevalence of non-specific lower leg pain in women during their prenatal period, there are no known prevalence numbers of non-specific lower leg pain in the postnatal period.

The most debilitating and common musculoskeletal problem in the postnatal period is back and sacroiliac joint pain.⁵ To our knowledge, there are no studies that have investigated the aetiology of postnatal non-specific lower leg pain. As investigators we can speculate as to the contributing factors for the lack of research in the prevalence and aetiology of postnatal non-specific lower leg pain. Therefore, it could be speculated that postnatal non-specific lower leg pain is not common since no prevalence numbers are available. Another consideration and perhaps the most likely reason is that much of the lower extremity pain is self-limiting with symptom resolution typically seen 4 months after delivery.⁷ Additionally, the hypothesized three primary causes for prenatal calf pain are hormonal, edema, or biomechanical causes,^{7,8} all of which should normalize after delivery. However, anecdotally there are some women who continue to have leg pain in the postnatal period. For those women who do not gain resolution of their symptoms to our knowledge, there are no specific treatments described in the literature.

There is an array of interventions available for physical therapists to utilize when treating non-specific chronic pain associated with musculoskeletal dysfunction. These interventions include soft tissue

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mobilization/massage,⁹ therapeutic modalities such as ultrasound¹⁰ or transcutaneous electric nerve stimulation,¹¹ and therapeutic exercise.^{12,13} The evidence supporting one intervention as being superior over another is unclear. The intervention to be described in this case study is a manual therapy treatment approach that combines instrument-assisted soft tissue mobilization (ISTM) with therapeutic exercise to address soft tissue dysfunction. According to manufacturers, ISTM-utilized instruments that are uniquely shaped enable a precise application of force and specific detection with localization of soft tissue lesions during treatment; the different instruments also allow a user to apply different strokes and depths of treatment.¹⁴ ISTM is based upon the concepts of cross-fibre massage (CFM). CFM is a manual technique specifically applying forces directed transverse to the direction of the underlying collagen substructure in order to induce physiological and/or structural tissue changes.¹⁵ CFM is different from typical manual techniques since there is little motion between the therapist's contact and the patient's skin; instead motion occurs between the subcutaneous tissues over the deeper connective tissue. The practice of CFM with rigid instruments is a type of ISTM. Preliminary results in animal models and clinical studies indicate that ISTM may be beneficial in promoting soft tissue remodelling and healing.¹⁶⁻²¹

There are no clinical reports to date on the use of ISTM with postnatal calf pain. The purpose of this case study is to illustrate how ISTM can be used to treat a patient with a 2-year history of postnatal chronic calf pain.

Case Description

Patient history

The patient was a 35-year-old female with a 2-year history of right calf pain. The onset of her calf pain was during the last trimester of her first pregnancy following the onset of severe lower leg edema. The calf pain was localized to her right mid calf, described as a dull ache, varying between constant and intermittent pain for the last 2 years. The patient rated her pain at 2/10 on the day of her examination, 0/10 at best and 5/10 on her worst day. The calf pain was frequently present at rest and the patient reports that she had no relieving activities. Her symptoms were aggravated by direct pressure on the calf such as crossing her legs, and also by the following activities which created tension in her calf; lifting her 35 lb son, prolonged standing, and walking up stairs. Lastly, she had stopped performing fitness activities because of her right calf pain limiting her ability to jog or strength train. She was limited functionally in her ability to perform her

necessary activities of daily living of prolonged standing, lifting her son, walking up stairs, and performing an exercise regimen.

Prior to the patient being referred to physical therapy, she had received a thorough medical examination and a number of diagnostic tests. A radiologist reported that she was clear of any significant vascular abnormalities or muscle edema as evaluated through an ultrasound Doppler study and magnetic resonance imaging (MRI) with contrast. She also had a plain radiograph performed to rule out any bony abnormalities or tumors, which were normal. Additionally she had laboratory tests of her blood and she had normal blood chemistry and complete blood count tests. Her physician prescribed her a 2-week dose pack of oral corticosteroids and the patient reported no change in her symptoms during or after this medication. Additional history related to her pregnancy was that the patient did develop gestational diabetes; otherwise she had a normal delivery and no other medical concerns.

Systems review

Based on the location of pain, the lack of relieving factors and that lifting was an aggravating factor, a thorough system review was required to rule out vascular, neurological, or proximal joint dysfunction. Vital signs were not measured at the initial evaluation.

Cardiovascular findings

There were no significant findings with clinical arterial or venous testing of the lower extremity. The clinical arterial and venous tests performed were the assessment of lower extremity pulses, palpation of limb temperature, and venous filling time. The pulse assessment consisted of bilateral palpation of the femoral, posterior tibial and pedal pulses with pulses reported as present or absent. The patient had pulses present in all locations bilaterally. There was no temperature difference palpated between limbs and venous filling time was 12 seconds, which is within normal values.²² The sensitivity and specificity of palpation in assessing peripheral pulses vary according to the expertise of the clinician and the location of the pulse. Studies have shown that physicians who are not vascular specialists may fail to detect 40% of the posterior tibial pulses and therefore other objective criteria to investigate vascular disease should be used.²³ McGee and Boyko²² reported that the important physical signs to determine the probability of arterial disease are the presence or absence of pedal pulses, a unilaterally cool extremity, and prolonged venous filling time (greater than 20 seconds); therefore, the patient in this case report had a low probability for any peripheral arterial disease.

Neurological findings

Patellar and Achilles tendon reflexes were performed and were symmetrical and normal graded at +2. Neuromeningeal testing was performed with a straight leg raise and slump test, and both tests were unremarkable.

Endocrinological and integumentary findings

A system review of the endocrinological system was performed through a series of questions to determine the presence of any problems related to a change in appetite, temperature intolerance, headaches, absence of perspiration, cramps, edema, unexplained weakness, sleep disturbance, and joint or muscle pain. The patient reported no integumentary problems and no recent rashes, skin, nail, or hair growth changes. Additionally on visual observation, she did not present with any skin or nail lesions.²⁴

Gastrointestinal findings

The patient reported no gastrointestinal symptoms and no nausea, vomiting, or problems with bowel or bladder function.

Musculoskeletal findings for proximal joints

Proximal joints were screened to rule out any dysfunction with the hip, sacroiliac joint (SIJ), or lumbar spine. All of the clearing tests performed were negative, which means that all tests were pain free and did not provoke any of the patient's typical symptoms. The clearing test performed for the hip was the flexion, abduction and external rotation test, which for those patients with osteoarthritis and one plane of restricted movement, the sensitivity is 100% and specificity is 42%; and for those patients with three planes of restricted movement, sensitivity is 54% and specificity is 88% with a likelihood ratio of 4.4.²⁵ In an athletic population a positive flexion, abduction and external rotation test has been shown to be 88% sensitive for intra-articular pathology.²⁶ The SIJ was screened using the provocation tests described by Laslett *et al.*;²⁷ when three of the six provocation tests are positive, sensitivity is 94% and specificity is 78% with a positive likelihood ratio of 4.29. When all six SIJ provocation tests are negative, the SIJ as a source of pain can be ruled out.²⁷ The lumbar spine was screened with a McKenzie evaluation; the patient had no pain with repeated movement testing. The reliability of the McKenzie approach has been extensively studied in the literature, with an inter-tester agreement of syndrome categories determined to be highly reliable with $k=1.00$ in properly trained therapists.²⁸ The therapist performing the screening tests is certified in the McKenzie Method of Mechanical Diagnosis and Therapy.

Imaging

The MRI with contrast was considered normal and it was stated by the radiologist that there were no

Figure 1 Coronal MRI with contrast, identifying the dense soft tissue abnormality in the right calf.

vascular or musculoskeletal abnormalities visualized. However, the physician reported the presence of a small superficial venous tissue network in the coronal image of the right calf that corresponded to the patient's self-reported pain location (Fig. 1).

Physical examination tests and measures

To improve the reliability of the tests and measures, two examiners (FK and EG) both performed each objective measurement and were blinded to each other's measurements at the time of examination. The primary examiner (FK) then compared measurements with the secondary examiner (EG) to ensure that all measurements were within the standard error range. Neither of the examiners were the treating therapist (AB) in order to improve the reliability of the initial and final outcome measurements.

The patient exhibited minimal impairments on examination. All tests and measures are reported in detail in Table 1. She had a mild postural abnormality of both lower extremities, a slight muscle strength difference in her plantar flexor strength, asymmetrical calf muscle length, and pain in her right calf. The most significant examination finding was the multiple soft tissue nodular restrictions detected on manual and instrument palpation of the right calf predominantly detected in the mid region of the gastrocnemius muscle. The instruments provide a reverberating sense when passed over fibrotic areas. Additionally the patient reported significant tenderness during palpation of her calf, rating her pain at 8/10 during deep palpation. There was no range of motion deficits and circumferential calf measurements were equal. There was also no calf muscle length deficit in the right calf; however, there was an asymmetry noted, with the right gastrocnemius and soleus measurements being greater than the left. The calf muscle length was screened with a lunge test

which uses the tibial inclination angle to provide an indirect measurement of muscle length. The lunge test is considered an indirect measurement of muscle length since limitations in talocrural joint motion will affect the motion, which is a possible explanation for the asymmetry noted. To measure her functional limitation, the lower extremity functional scale (LEFS) was used as the assessment tool. The LEFS has been shown to be reliable and have construct validity; also the test–retest reliability is excellent ($R=0.94$).²⁹ The patient rated herself at a 74/80 on the LEFS at her initial visit.

Clinical impression

After the examination completion, it was determined that the patient had only three impairments: (1) mild postural deficit in lower extremities; (2) decreased endurance with single leg calf raises; and (3) right calf pain. Functionally she was limited in her ability to perform activities which caused direct pressure or tension to the posterior right mid calf, specifically sitting with her legs crossed, so the right calf was resting on the left leg, walking up stairs, standing for prolonged periods, and lifting loads of 35 lb or greater. The patient was able to report the inability to specifically lift 35 lb without right calf pain since that

Figure 2 Instruments utilized for treatment: GT1, GT3, GT4, and GT5 (Graston Technique; TherapyCare Resources Inc.).

was the current weight of her 3-year-old son. Taking into consideration the patient's history, imaging, and examination findings, the initial clinical impression was impaired motor function and muscle performance associated with connective tissue dysfunction.³⁰ The clinical impression was formed from the imaging and examination, which detected limited soft tissue mobility within the mid region of the right calf over the area of the superficial venous tissue network. There were no noticeable deficits in range of motion or joint mobility at this point nor did the patient appear as if she had localized inflammation since the calf girth was

Table 1 Physical examination tests and measures

Test/measure	Initial examination		Explanation of findings
Posture	Rearfoot to leg orientation, 6° valgus. Mild genu recurvatum with hip internal rotation.		The postural findings were present bilaterally.
Gait	Unremarkable		
Active range of motion(ankle)	Left	Right	All range of motions findings were measured using a standard goniometer. ³⁸
Dorsiflexion (knee straight)	8°	8°	
Dorsiflexion (knee bent)	10°	10°	
Plantarflexion	50°	52°	
Inversion	20°	20°	
Eversion	26°	30°	
Muscle strength (ankle)	Left	Right	Ankle dorsiflexion, inversion, and eversion were measured via manual muscle testing described by Cuthbert <i>et al.</i> ³⁹ Plantarflexion strength was measured according to the number of single leg calf raises the patient could perform. ⁴⁰
Dorsiflexion (knee straight)	5/5	5/5	
Dorsiflexion (knee bent)	5/5	5/5	
Plantarflexion	5/5 (25 repetitions)	4+/5 (22 repetitions)	
Inversion	5/5	5/5	
Eversion	5/5	5/5	
Muscle length	Left	Right	Hamstring length was measured as passive knee extension from 90/90 position. ⁴¹ Gastrocnemius and soleus muscle length was measured indirectly in standing via the tibial inclination angle, using a goniometer. ^{38,42}
Hamstring length	–20°	–20°	
Gastrocnemius length	16°	22°	
Soleus length	18°	26°	
Muscle girth 5 and 10 cm distal to tibial tuberosity	Left 34.5 cm 34 cm	Right 34.5 cm 34 cm	
Palpation	Patient was acutely tender in the mid region of the gastrocnemius muscle in the right calf muscle compared with the left. Large nodular restrictions were detected in the painful area of the right calf.		Palpation was performed manually and also instrument-assisted. Patient reported pain at 2/10 in left calf and 8/10 in right calf during instrument-assisted soft tissue palpation.
Numerical pain rating scale	Now 2/10; worst 5/10; best 0/10		Self-reported pain ratings on a 0–10 visual analogue scale.
Lower extremity functional scale (LEFS)	74/80		Self-reported deficits in sections regarding running, stairs, lifting, and recreational activities.

symmetrical and she did not respond to a dose pack of oral corticosteroids.

The plan of care was for 6 weeks or eight visits consisting of a form of ISTM (Graston Technique®; TherapyCare Resources Inc., Indianapolis, IN, USA) which utilizes specifically designed patented stainless steel instruments combined with a targeted stretching and strengthening program. The ISTM portion of the treatment protocol used four different instruments (GT1, GT3, GT4, and GT5; Graston Technique; TherapyCare Resources Inc.) (Fig. 2). The primary goals of treatment were to restore the patient to her previous level of function which included the ability to stand for 2 hours, sit cross-legged, and walk up stairs with no right calf pain. In addition, the patient had a goal to be able to lift 40 lb from floor to waist without right calf pain, so she could lift and care for her child.

Intervention

Although the lesion was described radiologically as a small superficial venous network, the subsequent physical examination revealed multiple soft tissue nodular restrictions. Based on the long duration of the symptoms, and the obtained negative vascular tests, it was deemed safe to address the soft tissue restrictions. During each treatment session in the case study, interventions were applied in the following sequence: a warm-up via brisk walking for 5 minutes, 6–8 minutes of ISTM on the posterior right calf, stretches for gastrocnemius and soleus, eccentric calf exercise, and ice for 10 minutes to control inflammation. The treatment duration for the ISTM was based on the recommended clinical use of ISTM in preclinical studies demonstrating the efficacy of ISTM,^{16,17} previous clinical case series,^{20,21} and clinical expert opinion. The stretching exercises consisted of standing gastrocnemius and soleus stretches, repeated five times with a 30-second hold, twice daily. The eccentric calf exercises were single leg calf lowers with the right leg, performed for 10–15 repetitions, two sets, once daily. The dosage for the eccentric calf exercises was established through three guiding principles: (1) the philosophy of the Graston Technique is to perform high repetition, low load strengthening exercises; (2) to improve the endurance of the patient's single leg calf raise; and (3) to use an eccentric exercise dosage that was lower than the standard established for chronic non-insertional Achilles tendinopathy,¹² in order to minimize the potential treatment effect of the exercise.

Cryotherapy is typically used in conjunction with the ISTM and exercise since one of the consequences of targeted soft tissue mobilization and in particular ISTM is bruising over the site of the soft tissue dysfunction. Bruising did occur over the treated area

Figure 3 Right calf showing a typical bruise seen 24 hours after treatment.

in the patient in this case study. The photograph in Fig. 3 shows a typical bruise seen 24 hours after treatment. Notably when the bruising and lesion seen on the MRI (Fig. 1) are compared, they appear to be in the same location.

The patient over an 8-week period received nine treatment sessions. Typically ISTM treatments are recommended at a frequency of two per week; however, in this case study the patient had to travel for work so the original plan of care was extended by 2 weeks and one visit.

Outcomes

On reassessment the soft tissue quality of the right calf was considered normal, meaning that the soft tissue was supple and easily moved against underlying tissue without the presence of any abnormalities such as nodules, ridges, indurated, or fibrous areas with manual palpation. Reassessment of the soft tissue was also performed with the instruments and no restricted fibrotic areas were detected. Another indicator that her soft tissue quality had improved was the patient's self-reported pain rating with palpation; it was 8/10 on the initial evaluation and 0/10 at the reassessment. The right calf strength was graded at 5/5, where the patient was able to complete 25 single calf raises, previously she only completed 22 repetitions. Her pain rating on the numerical pain rating scale was 0/10 at rest and 0–1/10 with activity, with a pain improvement of 4 representing a clinically meaningful change.³¹ The final LEFS score was 80/80, which translates to a 6-point improvement and return to full function.²⁹ A pre- and post-treatment comparison of these significant tests and measures is shown in Table 2.

Follow-up was performed at 1 month and 4 months, there was no return of soft tissue abnormalities and the patient had no pain with palpation of the previously problematic area. Unfortunately the investigators were unable to get a repeat MRI because the patient became pregnant 3 months after the conclusion of treatment.

Discussion

A patient with chronic, non-specific, postnatal calf pain was successfully treated using a form of manual therapy, ISTM, combined with a targeted stretching and strengthening program. Her symptoms were resolved upon discharge and she returned to her prior level of function in a timely manner. It is likely that her symptoms were due to soft tissue dysfunction based on changes in the palpation findings over time and the initial MRI findings. A repeat MRI would have supported this hypothesis; however, this was not obtained due to previously stated reasons. It is likely that the demonstrated changes were related to the physical therapy intervention in this chronic case, although the positive treatment effect cannot be isolated to ISTM alone.

In order to understand how the symptoms were treated successfully with this targeted manual therapy approach, it is necessary to consider why the condition may have started. The contributory causes of the patient's myofascial dysfunction may have been hormonal, edema-related, or biomechanical. The hormones during pregnancy to consider are relaxin and progesterone. Relaxin causes activation of the collagenolytic system and alteration of the ground substance of connective tissue by increasing water content and decreasing viscosity with an overall net effect of remodelling of connective tissue.⁷ Anytime remodelling occurs in connective tissue, it is possible that it occurs in an imperfect manner leading to potential myofascial dysfunction. An increase in progesterone during pregnancy may also provide an answer. As progesterone increases, relaxation of the muscular wall of blood vessels occurs, thereby decreasing venous return and leading to dependent edema.⁸ Dependent leg edema has the potential to cause pain during the pregnancy and in the postnatal period. During pregnancy, the edema

causes localized inflammation, exerting pressure on local nerves and leading to lack of adequate nutrition to the cells, all of which result in pain.³² Postnatal, when the hormonal influences have normalized and the edema resolved, it would be expected that the calf pain would resolve. However, it is possible that the localized inflammation due to the edema progresses to chronic inflammation and due to increased collagen cross-linking, soft tissue restriction is the end result.³³ The third potential mechanism for the development of chronic soft tissue dysfunction in a calf postnatal is the biomechanical changes during pregnancy. Lower extremity musculoskeletal dysfunction could be affected by changes in gait pattern, centre of gravity changes, weight gain, and increased overall lower extremity demand.⁷ It is possible that these biomechanical changes may result in unresolved impairments, scar tissue, or soft tissue dysfunction.

In addition to considering the potential underlying mechanisms for chronic postnatal calf pain due to soft tissue dysfunction, it is important to explore how the intervention applied in this case study affected the soft tissue. ISTM provides a form of specifically directed mechanical stimulation of the soft tissue. Since it is known that cells (e.g. fibroblasts) are mechano-sensitive and respond to external loading of their environment, manipulation of the soft tissue has the potential to induce physiological and/or structural tissue changes.^{16,34,35} Initial animal model studies found that ISTM applied to chemically induced rat Achilles tendon injuries increased fibroblast proliferation and activation, especially at higher therapeutic pressures, which may be related to improved healing.¹⁶ Another more recent animal model study on injured knee medial collateral ligaments, ISTM-treated ligaments had improved collagen fibre alignment which were stronger, stiffer and could absorb more energy 4 weeks post-injury.¹⁸

Table 2 Comparison of tests and measures pre- and post-treatment

Test/measure	Initial examination (pre-treatment)		Discharge (post-treatment)	
	Left	Right	Left	Right
Muscle strength (ankle)				
Plantarflexion	5/5 (25 repetitions)	4+/5 (22 repetitions)	5/5 (25 repetitions)	5/5 (25 repetitions)
Palpation	Patient was acutely tender in the mid region of the gastrocnemius muscle in the right calf muscle compared with the left. Large nodular restrictions detected in the painful area of the right calf.		The patient reported no pain during manual and instrument assisted palpation. No fibrotic lesions were detected in the right calf.	
Numerical pain rating scale	Now 2/10; worst 5/10; best 0/10		Now 0/10; worst 1/10; best 0/10	
Lower extremity functional scale (LEFS)	74/80		80/80	

Clinical pilot studies using ISTM have also demonstrated positive outcomes for diagnoses such as carpal tunnel syndrome,¹⁹ chronic ankle pain,²⁰ patellar tendinopathy, plantar fasciitis, and Achilles and supraspinatus tendinosis.³⁶ Mechanotransduction of the ISTM force provides an underlying mechanism for tissue remodelling and repair in the presence of chronic soft tissue abnormality.

There are potential implications on future clinical practice with this manual therapy approach. An obvious advantage of ISTM to the patient is that it is a non-invasive and non-pharmaceutical treatment option. Furthermore, ISTM offers a mechanical advantage afforded to the clinician as well as the potential to minimize the clinician's joint stress. Campo *et al.*³⁷ found wrist and hand injuries to be the second most common work-related musculoskeletal disorder of physical therapists when studied as a 1-year incidence rate. Allowing the tools to absorb mechanical stress rather than the therapist's hands has the potential to reduce over-use injury to the treating clinician. The specific technique utilized in this case study is a form of ISTM, which utilizes specifically designed patented stainless steel instruments combined with a targeted stretching and strengthening program. Since the manual therapy is combined with exercise, the results may have been due to the combined treatment approach rather than the ISTM. It is also challenging to draw definitive conclusions about ISTM since there are no randomized controlled trials reported in the literature to support this case study's findings. Additionally there are no studies on ISTM dosage in an animal model, specifically investigating the optimal duration and depth of application.

In conclusion, the patient in this case study, who had a 2-year history of postnatal calf pain, demonstrated complete resolution of her symptoms using a non-invasive manual approach including ISTM. Future directions of study should include dosage studies in an animal model and randomized clinical trials in the application of the ISTM technique for musculoskeletal dysfunction.

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