Massage Therapists' Association of British Columbia

Clinical Case Report Competition

West Coast College of Massage Therapy

Summer 2011

First Place Winner

Matt Thompson

The effects of myofascial release on chronic sesamoiditis and functional hallux limitus

P: 604.873.4467
F: 604.873.6211
research@massagetherapy.bc.ca
massagetherapy.bc.ca

Table of Contents

Abstract

Objective: To evaluate the effectiveness of massage therapy in the form of myofascial release to the first ray complex (hallux, sesamoids, first metatarsal) and it's associated soft-tissue structures. The pathology affecting this region specifically is chronic sesamoiditis and functional hallux limitus (FnHL). The goal of this study is to reduce pain and restriction at end range dorsiflexion of the first metatarsophalangeal (MTP) joint, increase neuromuscular activation of the fibularis longus (FB) and flexor hallcuis longus (FHL) muscles, and improve the Center of Force (CoF) trajectory in the plantar surface of the foot to a more lateral trajectory, thereby reducing pressure and medial load on the first ray and first MTP and sesamoids.

Case Selection: This study was conducted on a 31 year old male with chronic and recurrent right foot only sesamoiditis. The injury was acquired during a day of prolonged hiking that consisted of continuous ascending and descending of steep terrain. The injury resulted in pain at end ranges of both passive and resisted dorsiflexion of the first MTP joint, pain on weight bearing exacerbated during toe off phase of gait, and weak and inhibited FL and FHL muscles.

Methods: The treatment protocol consisted of 5, 60 minute treatments over the course of 15 days. Both active and static myofascial release techniques were administered focusing on the posterior, deep posterior and lateral compartments of the leg. This was accompanied with remedial exercise of both strengthening and stretching along with hydrotherapy.

Results: The patient experienced decreased pain in the first MTP joint during toe off phase of gait as well an increase in the strength of the FL muscle during isometric muscle testing. There was also a change with respect to the CoF trajectory resulting in an increase in the load of the lateral column of the foot.

Conclusion: With respect to this patient myofascial release techniques accompanied with remedial exercise and hydrotherapy were able to relieve signs and symptoms associated with sesamoiditis and FnHL. To truly validate the results of these treatment protocols of a larger sample population would be required to reduce the patient dependant variables and focus specifically on the pathology and its clinical manifestations.

Key words: Myofascial release, fascia, first ray, hallux, sesamoiditis, functional hallux limitus, first metatarsolphlangeal joint, tibialis posterior, fibularis longus, flexor hallucis longus.

Anatomy and Biomechanics of the Hallux and First Ray:

The first ray is a single foot segment composed of the hallux, the first metatarsal and medial cuneiform bones. The hallux is composed of the proximal and distal phalanges. There is an intricate anatomical relationship between the first ray, hallux and its involved musculature. Tibialis posterior (TP), tibialis anterior (TA) and FL all have direct attachments to the first ray thus contributing significantly to the osteokinematics and arthrokinematics of this structure. All three of these muscles are located in different compartments of the leg as well with separate innervations. Even though these muscles all arise from separate compartments with different innervations they all converge and insert into the first ray structures and contribute to functional support of the medial longitudinal arch of the foot forming what many call the "stirrup muscles". Two other important muscles, FHL and flexor hallucis brevis (FHB) have considerable influence on both the first ray and the medial arch but do not have direct attachments to the first ray, instead attaching to the proximal and distal phalanx of the hallux. The main function of these two muscles is flexion of the hallux, a key component of propulsion in the toe off phase of gate. Two other important structures that are incorporated with the hallux and first ray complex are the sesamoid bones. The sesamoid bones of the hallux present with a unique anatomical configuration, invested in the tendons of the FHB and lying in the synovial joint capsule of the first MTP joint (Glasoe, 1999, p. 856) They absorb the majority of the weight of the first ray, protect the tendon of the FHL under the first metatarsal head and help to increase the fulcrum of the intrinsic musculature of the first ray to provide a strong plantarflexion force at the first MTP joint (Anwar, 2005, p. 41) One of the most crucial structures of the foot with relation to gait is the first MTP joint. The first MTP joint is a condyloid synovial joint with two degrees of freedom. Normal function of the first MTP joint is critical for gait. Lawrence (1994) states that "Under most circumstances, 65 to 75 degrees of dorsiflexion of the hallux on the first metatarsal is required for normal gait." (p.529) Considering the complexity of the above mentioned structures altered or improper biomechanics of the hallux and first ray complex together have implications in a variety of different foot pathologies.

Anatomy and Physiology of Myofascial Release:

Fascia is a slightly mobile connective tissue, that is composed of an elasto-collagenous complex that forms a three dimensional web throughout the body from head to toe. (Rao, 2011, p. 5) Functionally the fascia serves to surround and infuse all structures in the body and aids in protection and support of these structures.

Fascia has unique mechanical and electrical properties. The mechanical portions have both a viscous and elastic deformation component. The electrical aspect consists of piezoelectricity meaning electricity resulting from pressure. The viscous component is more permanent whereby when a prolonged stretch or load is applied breakdown of the irregular bonds between collagen molecules, fibers and cross links occur. The elastic component is more temporary and once the sustained stretch or load is removed there is a "post-immobilization" or recoil effect and the elastic fibers return to their previous orientation and length. (Rao, 2011, p. 18) These two mechanical components produce a "viscous flow phenomenon". Rao, (2011) implies that "A gentle sustained pressure applied slowly, will allow a viscous medium to flow to a greater extent than a quickly applied pressure."(p.11) The piezoelectric aspect consists of connective tissue structures establishing minute voltage currents in response to stress or strain resulting in a more linear re-alignment of fascial fibers. The kinematics of the human body depend on connective tissue for support and efficiency, it is the proper distribution of these tissues that is needed for optimal function. In response to trauma the fascial system tightens as a protective mechanism. Barnes (1997) discusses that

"Fascial restrictions can create abnormal strain patterns that can restrict or drag osseous structures out of true alignment, resulting in compression of joints and causing pain and or dysfunction. Neurological and ischemic conditions can also manifest secondary to compressive forces from these restrictions. Reductions in functional length and contractile potential of muscular components of the myofasical system will also be evident with fascial limitations. This is specifically evident at the ground system/cellular level as well as mechanically from collagenous tinsegrity in which the ground substance solidifies, the collagen develops cross links, is fibrous and dense, and the elastin loses its resiliency." (p.235)

By adopting the mechanical and electrical components of fascia in combination with manual therapy the physical properties of these tissues will therefore change in response to manual or mechanical strain induction, electrical or mechanical field induction as well as thermal induction. (Rao, 2011, p. 19)

Pathophysiology:

FnHL and sesamoiditis are two pathologies that are directly associated with the first MTP joint resulting in pain and a decrease in functionality. Research done by Wilder (2004) discusses that "A mismatch between overload and recovery can lead to breakdown on a cellular, extracellular, or systemic level, however. At the cellular level repetitive overload on tissues that fail to adapt to new or increased demands can lead to tissue breakdown resulting in injury." Due to this complex anatomical relationship with other pain sensitive structures in the region of the first MTP joint, diagnosis and treatment of these conditions can be very challenging.

Sesamoiditis is defined as the inflammation of the structures involving the sesamoids.(Anwar, 2005, p. 41) Sesamoiditis is due to repetitive micro trauma to the first MTP joint.(Lawrence, 1994, p.237) A rigid plantar flexed first ray and pes cavus feet are cited as contributing factors to the development of sesamoiditis; the prevailing theory is that plantarflexion and eversion of the first metatarsal head place the tibial sesamoid in a more vulnerable position.(Lawrence, 1994, p. 237)

FnHL is defined as a decrease in the range of motion beyond normal at the first MTP joint. (Lawrence, 1994, p. 531) There are a variety of structural and functional causes, including a long first ray or long hallux creating jamming at the first MTP joint; hypermobility of the first ray secondary to proximal hyperpronation, creating distal instability; neuromuscular disorders affecting the ability of the FL to plantar flex or pull down the first ray; lack of available range of motion of the first ray as a result of degenerative joint disease; and structural first metatarsal elevatus (Lawrence, 1994, p. 531).

When dealing with pathologies associated with the first MTP joint it is of equal importance clinically to asses other areas than just the first MTP joint. Due to the lack of motion at the first MTP joint the patient will generally redirect motion to the lateral portion of the foot. Depending on the type of foot and available motion of the first ray the patient may present with lesions beneath the second metatarsal or lesions on the lateral border of the foot. Severe metatarsalgia pain may be of primary concern to the patient rather than pain around the first MTP joint due to compensation. (Lawrence, 1994, p 531)

Case Introduction:

The case study patient was a 31 year old male health care practitioner. He is a 6’1” 185lbs ecto/mesomorph who leads a very active lifestyle. His physical activity consists of trail running and cross training using free weights with a frequency of 5-6 times per week. The mechanism of injury was to the right foot due to repeated dorsiflexion of the first MTP joint under increased load from wearing a backpack (approximately 30lbs) while ascending and descending steep terrain over the course of 10 hours. During the acute phase of the injury pain in the form of stiffness located at the origin of FHL was the primary symptom. During the sub-acute phase of the injury the client received treatment from a Registered Massage Therapist (RMT) and a Doctor of Chiropractic Medicine (DC). With no true long term resolution from the injury the client was referred for radiographic imaging and bone scan. The results conclude that there was no evidence of stress fractures in the first ray hallux complex. However there was evidence of medial bipartite sesamoid. This is a congenital abnormality resulting in the bifurcation of the sesamoid bone. As well indications of the early stages of osteoarthritis of the first and second MTP joints, the middle and intercuneiform articulations, and the talonavicular joint were present.

The patient's current complaint is a chronic dull ache around the first MTP joint with weight bearing. This is aggravated with increased activity and or foot wear that have a stiff sole and or narrow toe box. In weight bearing the right hallux had limited dorsiflexion with passive movement and the left was capable of reaching the minimum required 45^{o}. During manual muscle testing weakness was evident in the right FL and FHL muscles. There was no pain during passive and active range of motion however pain was present during end range of resisted range of motion of the first MTP joint.

<u>Treatment Protocol:</u>

The treatment protocol consisted of 5, 60 minute treatments that took place over the course of 15 days accompanied with remedial exercises and hydrotherapy. All 5 treatments were nearly identical in all aspects. The main treatment modality that was administered was myofascial release with other accessory modalities such as Swedish and joint mobilization also being administered. The first application of myofascial release was an intermuscular technique. This was applied to the posterior compartment of the leg focusing on adhesion formed between the gastrocnemius and soleus muscles. This was followed by active myofascial release that was applied to FL and FHL following the entire course of these muscles. Deep stripping of FHB along the medial arch was carried out followed by a grade three distraction of the talocrural joint. Swedish effleurage was applied to the leg in general as a flushing technique to help promote venous return.

Hydrotherapy was applied post treatment in the form of an ice bath where the leg was submersed from the knee down for ten minutes to help reduce any inflammation resulting from the treatment. Contrast foot baths were carried out daily during the course of the treatments.

Remedial exercise consisted of both strengthening and stretching exercises. The strengthening component was focused towards the FL muscle and involved resistance exercises using therapeutic rubber bands. The stretching component was focused towards the posterior and deep posterior compartment of the legs.

Results and Analysis:

The patient's primary symptom was pain and discomfort with end range loading of the first MTP joint. The level of pain was established using a scale from one to ten, one being only slight discomfort and ten being excruciating. The client was asked to rate the pain during full dorsiflexion of the first MTP joint while performing a forward lunge having the front leg, knee and hip at 90^{o} of flexion and the rear leg, hip in neutral and the knee at 90^{o} of flexion touching the ground. This was carried out both in the morning of treatment and the morning after treatment to mitigate any false positives or negatives from post treatment hydrotherapy or inflammation caused from deep tissue treatment. A pain scale of 3.5 was established before the first treatment and this dropped to a 2.5 following the first treatment. This residual effect lasted for 2-3 days and was dependant on the client's activity level and footwear. The following 4 treatments followed a similar trend with the pain never getting any higher than a 4 pre-treatment and never lower than a 2 post treatment.

The primary signs of dysfunction were weak and inhibited right FL and FHL, along with abnormal (medial) CoF trajectory of the plantar aspect of the foot.

The FL and FHL were graded using a manual muscle testing procedure that has a scale from 0 to 5. The client received a grading of -4 which equates to holding the test position against slight to moderate pressure regarding the FL. When testing the FHL with the hallux in a neutral position a grading of 5 was given, however when the hallux was put into approximately 45^{o} of dorsiflexion a grade of +3 was given equating to holding the test position against slight pressure, this was accompanied with pain on resistance. With post treatment muscle testing the FL was graded as a 5 in all treatments. This residual effect only diminished slightly with pre treatment testing for the remainder of the study being at a +4 corresponding to holding the test position again moderate to strong pressure. The FHL had little to no improvement post treatment when tested in 45^{o} of dorsiflexion, however subjectively there was a reduction in pain upon resistance.

Center of Force (CoF) plantar pressure recordings were also taken pre and post-treatment during each session using F-Scan pressure mapping sensors and software. The F-Scan is a clinical diagnostic system that uses paper-thin force/pressure sensors placed inside a shoe to track pressure and force dynamics of the foot and lower limb in weight-bearing and analyze gait characteristics. The CoF trajectory is a measurement of the posterior to anterior (heel to toe) progression of a test subject's primary line of force in relation to plantar pressure as the foot moves through the three main phases of walking gait: heel contact, mid-stance and toe off. In this subject the right foot displayed a medially oriented CoF pre-treatment and a more laterally oriented CoF trajectory post-treatment in all cases.(see appendix 1 pre and post-treatment F-Scans) A medially oriented CoF trajectory increases plantar load on the first MTP and sesamoids and further increases the functional limitation in hallux dorsiflexion noted above whereas a laterally oriented CoF follows the lateral column through the heel contact and mid-stance phases of gait and reduces first MTP load to late mid-stance and toe-off as required for normal gait and engagement of the windlass mechanism. As shown in the F-Scan figure, in the pre-treatment recordings the CoF trajectory line follows the third and second metatarsals through heel contact and mid-stance and medially deviates to the 2nd metatarsal through toe-off. In the post-treatment recordings the CoF trajectory line follows the fifth and fourth metatarsals (lateral column) through heel contact and mid-stance and shows a much sharper medial deviation to the second and first metatarsals through toe-off. This would indicate an improvement in CoF trajectory in the foot post myofascial release treatment and has significant implications on the *prevention* and treatment of plantar pressure dependant pathologies such as sesamoiditis. Further, as demonstrated in the Force vs. Percentage graphs in Appendix 1 we see a delayed force/pressure curve at the forefoot (second peak in the graph images) in the post-treatment recording and a higher force amplitude suggesting improved activation and therefore stabilisation of the first ray and its associated structures. (Information obtained with regards to the F-Scan and CoF trajectory analysis was under the supervision of A. Janke Certified Pedorthist, C Ped C)

Conclusion:

The primary outcome of this case study was to research the validity of myofascial release in alleviating the signs and symptoms of sesamoiditis and FnHL as well as analyze the plantar force characteristics of the case subject's foot pre and post treatment. With regards to this specific individual the goals of reducing pain at end rage loading of the first MTP joint, increasing the strength of the FL muscle and improving CoF trajectory along the plantar aspect of the foot as well as redistributing force/pressure as a percentage of the gait cycle in favour of delayed forefoot loading were accomplished. However this case study does not represent enough data to apply the above findings to the noted pathologies. In conclusion a much larger sample population would be needed to aid in establishing a valid baseline of treatment outcomes geared towards the pathologies and their clinical presentations.

Appendix 1

White line on plantar surface of foot indicates CoF trajectory

Green line on graph indicates left foot and red line indicates right foot.

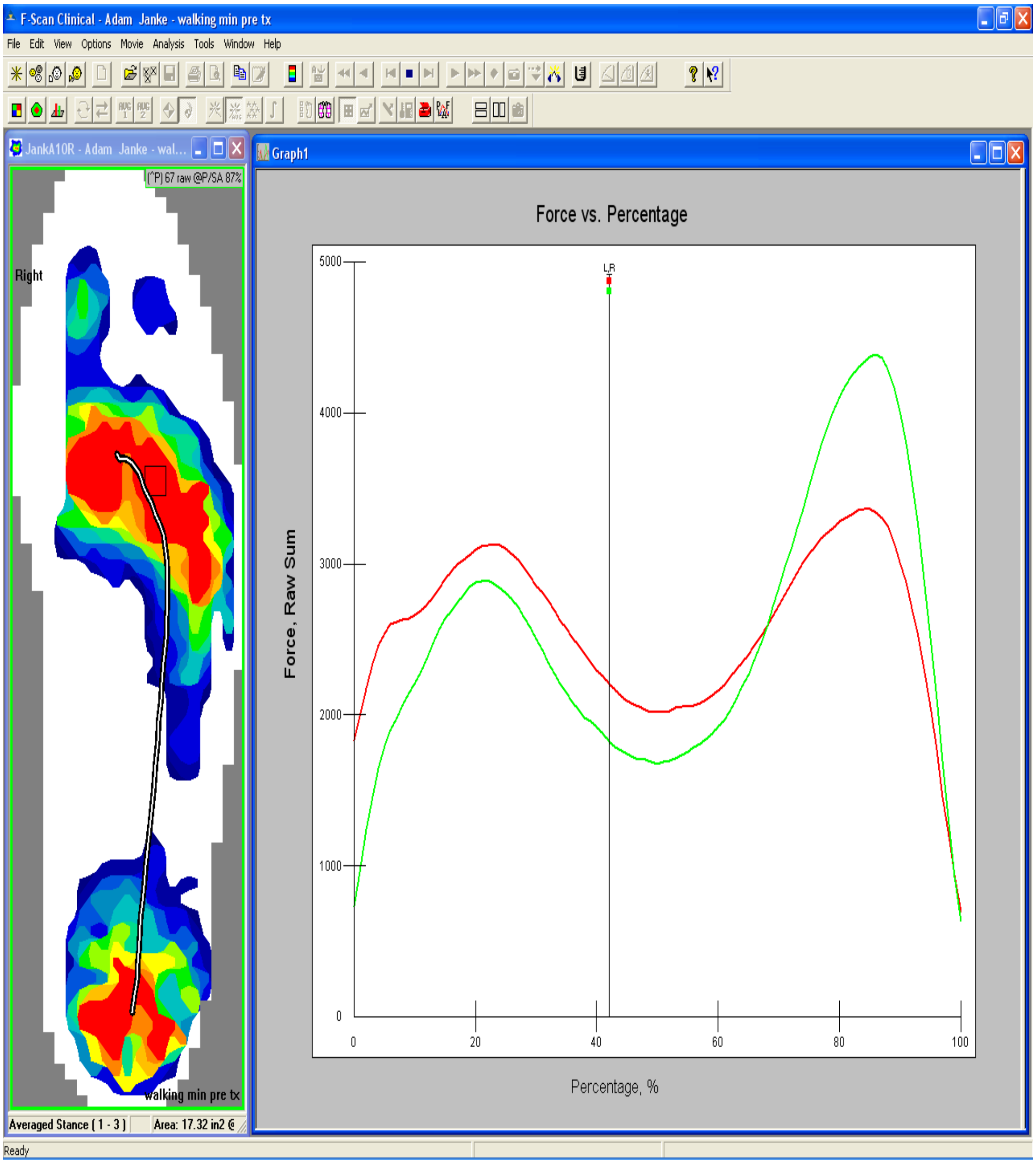

Figure 1a-Pre treatment F-Scan

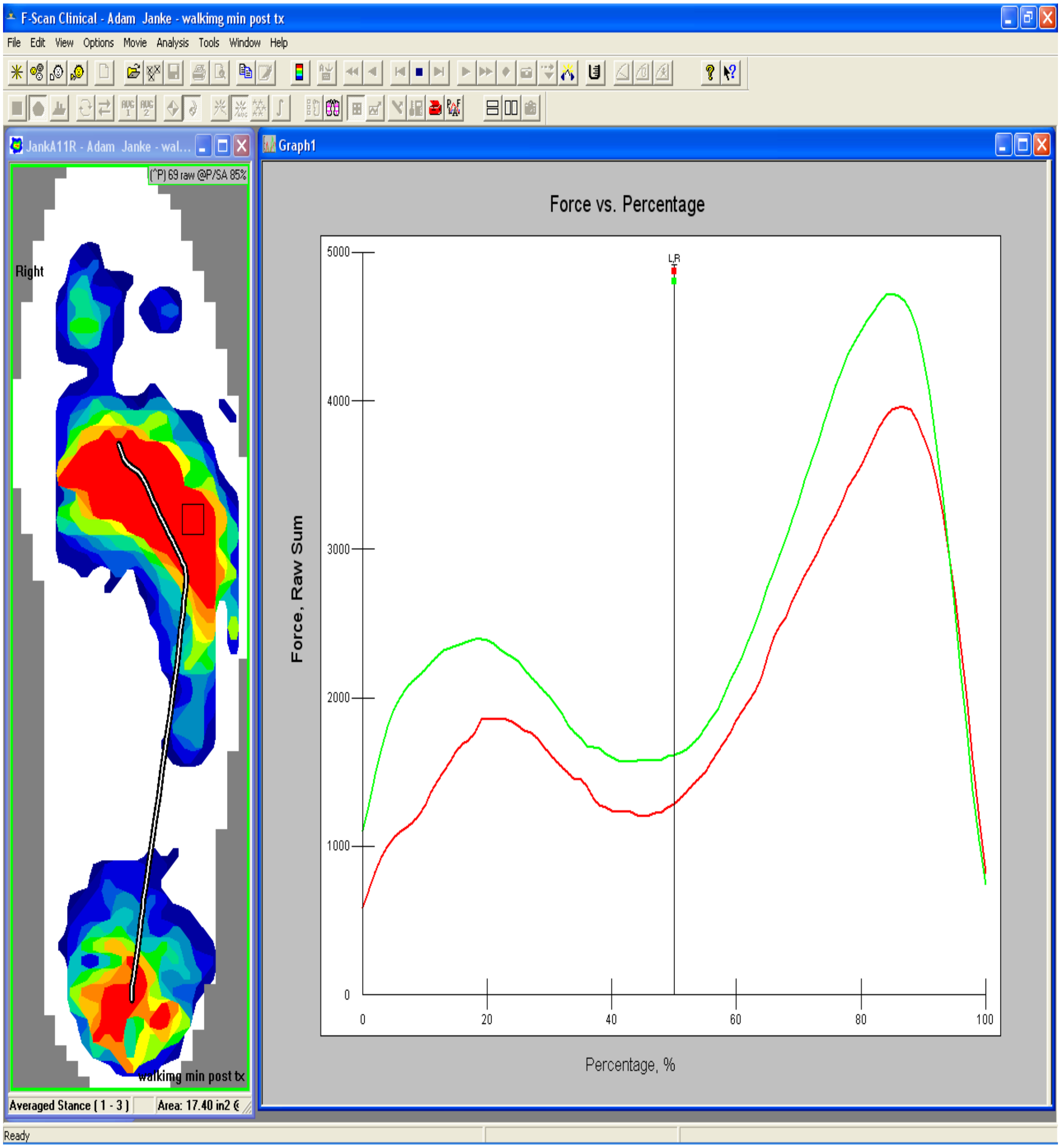

Figure 1b-Post treatment F-Scan

Citations

1. Anwar, R., Anjum, S.N., Nicholl, J.E. (2005) Sesamoids of the Foot. *Current Orthopaedics,* 19, 40-48. Doi:10.1016/jcuor.2005.01.001

2. Banks, S. Alan., Downey, S. Michale. (Eds.). (2004) *McGlamry's Forefoot Surgery.* Philadelphia, Pennsylvania: Lippincott Williams and Wilkins.

3. Barnes, M.F. (1997) *The Basic Science of Myofascial Release: Morphological Change in connective Tissue.* USA Pearson Professional.

4. Barr, P. Karen, MD., Harrast, A. Mark, MD, (2005) Evidenced-Based Treatment of Foot and Ankle Injuries in Runners. *Physical Medicine and Rehabilitation Clinics of North America,* 16, 779-799. doi:10.1016/j.pmr.2005.02.001

5. Coughlin, J. Michael. (2000) Common Causes of pain in the Forefoot in Adults. *The Journal of Bone & Joint Surgery (Br), 2000;82-B:781-90.*

6. Donatelli, Robert, MA, P.T. (1990) *The Biomechanics of the Foot and Ankle.* Philadelphia, Pennsylvania: F.A. Davis Company.

7. Glasoe, M. Ward., Yack, H. John., Saltzman, L. Charles. (1999) Anatomy and Biomechanics of the First Ray. *Physical Therapy. 1999;79:854-859.*

8. Lawrence, M. Oloff, D.P.M. (1994) *Musculoskeletal Disorders of the Lower Extremities.* Philadelphia, Pennsylvania: W.B. Saunders Company.

9. Lorimer, L. Donald., French, Gwen., O'Donnel, Maureen., Burrow, J. Gordon., Wall, Barbra. (Eds.). (2006) *Neale's Disorders of the Foot.* Philadelphia, Pennsylvania: Harcourt Publishers Ltd.

10. Rao, Natale. (2011) *Assesment and Treatment of Myofascial Tissue.* WCCMT. New Westminister.

11. Sammarco, James, G. MD. (1995) *Rehabilitation of the Foot and Ankle.* St. Louis, Missouri: Mosby-Year Book, Inc.

12. Taylor, M. A. John, DC., Sartoris, J. David, MD., Huang, Guo-Sbu, MD., Rensnick, L. Donald, MD. (1993) Painful Conditions Affecting the First Metatarsal Sesamoid Bones. *Radiographics, 1993;13:817-830*

13. Totora, J. Gerard. (2009) *Principals of Anatomy and Physiology 12th Ed.* Hoboken, New Jersey: John Wiley & Sons, Inc.

14. Wilder, P. Robert, MD., Sethi, Shikha, MD. (2004) *Overuse injuries: tendinopathies, stress fractures, compartment syndrome, and shin splints.* Clinics in Sports Medicine. 55-81 doi:10.1016/S0278-5919(03)00085-1