The goal of this study is to quantify the effect of non-invasive treatment for low back pain by calculating the Hysteresis Loop Area (HLA) using the Automated Anatomic Torsion Monitor (A-ATM).

Methods

Five normal subjects (two females, three males) were evaluated twice on the same day, and five patients with low back problems (four females, one male) were evaluated with the A-ATM before and after each of two treatments, with approval by NJIT IRB. The ATM rotates a passive supine subject’s pelvis, collecting torsion data that plots a hysteresis loop. By measuring the displacement as the loads are added and removed the rotational stiffness can also be determined using this device. This rotational motion is shared among numerous structures such as myofascial tissues, sacroiliac joints, thoracic, and the lumbar spine [1]. This device was developed to mimic the pelvic roll technique used by osteopathic physicians.

Procedures

On separate days, the HOMEDICS HHP-300 mechanical massager was used for ten minutes on the lumbar paraspinal muscles or the subjects had a 60 minute session of Rolfing® Structural Integration by an Advanced Rolfing™ practitioner (TF).

Results

Reproducibility Test: Normal subjects were tested twice, one hour apart. The mean percent change in HLA after one hour duration was 3.9%.

Effects of Massaging on the Low Back: Initial measurements on low back subjects showed a mean HLA of 0.85, compared to a mean area of 0.78 in the normal subjects (p<0.38). Both non-invasive treatments showed an improvement in HLA. Mechanical massager showed -12.5% change of HLA for patients after treatment (p<0.07), while manual massaging showed -15.7% change of HLA for the same patients (p<0.16). The negative sign indicates improvement.

Conclusion

This study was done to quantitatively evaluate treatment of the low back condition. The two treatments selected showed similar effects on mechanical function of the low back in persons with low back pain. The underlying effects of the mechanical massager should be further investigated as it is an economical method of treatment.

Reference

Collagen Deposition and Biomechanical Behavior During the Healing Process of Gastrocnemius Muscle Injury Treated by Ultrasound in Rats

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4.2.2 Background

Ultrasound (US) treatment stimulates collagen deposition, and the collagen maturation process can contribute to a better mechanical strength. Therefore, a quantitative study of collagen was conducted and the histological findings were correlated to the biomechanics data in a rat muscle lacerated injury model treated by pulsed US.

Methods

After lesion, rats were randomly divided into 2 groups: the US group was treated daily with 1 MHz pulsed ultrasound 50% at 0.57 W/cm² for 5 min, and the Control group did not receive any treatment. Each group was further divided into subgroups (n=5) for histological and biomechanical evaluation at postoperative (p.o.) days 4, 7, 14 and 24. The absolute volume of lesions was estimated using the Cavalieri principle in serial tissue sections stained by hematoxylin-eosin and stereology tools of vertical sections were used in picrosirius stained sections to evaluate the impact of US in absolute volume of collagen fibers within the lesion. A biomechanical analysis was performed to estimate the stress (KPa) and the rigid (N/mm).

Results

Although the histological pattern was similar in both treated and control groups, the absolute volume of lesion (mean ± SD, in mm³) is lower in all US subgroups when compared with the corresponding controls for each time p.o. (4 - 21.05 ± 4.37 vs 44.47 ± 6.09, p=0.02; 7 - 9.87 ± 4.49 vs 18.27 ± 3.27, p=0.017; 14 - 6.01 ± 1.82 vs 13.49 ± 4.95, p=0.016; 24 - 5.41 ± 1.57 vs 9.69±3.23, p=0.047). Stereological data showed that absolute volume (mean ± SD, in mm³) occupied by collagen was higher in treated lesions at 4 (7.58±2.68 vs 2.32±1.01, p=0.006) and 7 (5.65 ± 1.26 vs 1.91 ± 0.69, p=0.011) days p.o. The stress and the rigidity were greater at both groups (US and Control) as the healing process progressed, but the US treatment promoted an early improvement of these variables: Stress and Rigid at 4 days p.o., respectively (442.71±105.17 vs 287.90±71.66, p=0.049) and (2.47±0.37 vs 1.46 ± 0.41, p=0.036). At 24 days p.o. these variables were even better at the US group (Stress: 701.40 ± 83.96 vs 597.08 ± 29.72, p=0.039) and (Rigid: 3.99 ± 0.38 vs 3.38 ± 0.30, p=0.027).

Conclusions

Our study suggests that pulsed US induces a better functional recuperation, which in practice means that the US group is able to perform heavier work sooner.
A Multi-Modal Biosensor to Measure Soft Tissue Pain and Myofascial Trigger Points (MFTPs) for Evidence Based Practices

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Background

Chronic pain affects 1 in 3 Americans, costing up to $635 billion each year. [1] Subjective reports cannot distinguish the experience of pain from that due to actual tissue damage and palpation and pain questionnaires frequently underestimate pain. [2, 3] There is limited consensus on myofascial trigger point (MFTP) pain and claims for effective interventions need to be supported by objective evidence. [4]

Methods

A literature review on algometry, thermography, galvanometers, stethoscopes and analysis of research suggesting inflammations as the root cause of pain.

Results

Content validity shows inflammation as a root cause of pain. Inflammation is measurably elevated in active trigger points and sensitizes nociceptors causing hyperalgia (pain). [5, 6] Research literature supports algometry, galvanometers, thermography and stethoscopes as valid devices in measuring aspects of inflammation. However, these devices are individually limited, expensive and time consuming.

Conclusion

Combining these individual devices into a multi-modal biosensor provides concurrent measurements of inflammatory MFTP pain. Digitized data collected in a software program can show treatment outcomes, providing a tool for evidence based practice.

References

Are Child Bearing Hips a Risk Factor For Greater Trochanteric Pain Syndrome?

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Background and Purpose

Greater trochanteric pain syndrome (GTPS) can be painful and debilitating. Other than being female and over the age of 50, no risk factors have been evaluated for developing GTPS. We aimed to determine if pelvic or hip width predisposed women to GTPS.

Methods

Using a prospective observational case controlled study, 32 women with GTPS, 20 women having gluteal tendon reconstructions (GTR), 20 women with severe hip osteoarthritis (OA), and 21 asymptomatic (ASC) women were recruited from hospital waiting lists and the community. Anterior-posterior pelvic x-rays were measure and provided the following ratios: anterior inferior iliac spine: lateral acetabulum; anterior inferior iliac spine: superior aspect of the greater trochanter; anterior inferior iliac spine: lateral greater trochanter; anterior inferior iliac spine: superior aspect of the greater trochanter. The acetabular index and the femoral neck shaft angle were measured. Anthropometric measures of BMI, waist, hip and greater trochanter girth were taken, with waist to hip, and waist to greater trochanter ratios calculated. Data were analyzed using a one way ANOVA with post hoc Scheffe analysis, followed by multivariate analysis.

Results

No group difference was found for the pelvic or hip x-ray width ratios. The gluteal tendon reconstruction group had a more acute femoral neck shaft angle than the other groups (p = 0.007). The odds ratio (95% CI) of having a neck-shaft angle of less than 134°, relative to the ASC group, was 1.4 (0.52 to 3.75) for GTPS participants; 3.33 (1.26 to 8.85) for GTR participants; and 0.85 (0.28 to 2.61) for OA participants. The odds ratio of GTR relative to GTPS was 2.4 (1.01 to 5.6).

No group difference was found for BMI, or for the anthropometric measures other than the girth at the greater trochanter (mean [95% CI] in cm) ASC = 99.1 (94.7 to 103.5), GTPS = 105.9 (100.2 to 111.6), GTR = 103.8 (100.3 to 107.3), OA = 100.3 (97.7 to 103.9), (ANOVA: p = 0.036). Multivariate analysis confirmed that overall adiposity is a factor in discriminating between the groups, with the GTPS and GTR groups having a positive association with adiposity.

Conclusion

The risk of GTPS associated with female anthropometry lies in the adipose distribution and femoral neck angle.

Disclosure

No conflicts to disclose.
The Effects of Self Myofascial Release on the Plantar Surface of the Foot During Sledge Rebound Jumps

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Background
Various studies have demonstrated that fascia may play a more significant role in the human body than previously established. The majority of the research in this area is still focused around the physiological changes that occur during hands-on therapy. From this research numerous findings have been made, many of which could also be associated with an enhanced function. There is currently no known research investigating myofascial manipulation and performance. The purpose of this study was to investigate whether self myofascial release (SMFR) on the plantar surface of the foot could enhance dynamic strength measures.

Methods
Fourteen subjects, 9 male and 5 female, were recruited for the study. Subjects used SMFR on the dominant leg, allowing the non-dominant leg to act as a control. Measurements of contact time (CT), height jumped (HJ), flight time (FT), and reactive strength index (RSI) were obtained during single leg rebound jumps (RBJ) using a specially constructed force sledge apparatus. Reactive strength index (RSI) can be defined as the subject’s ability to change quickly from an eccentric to a concentric contraction and can be regarded as a measure of an individual’s explosive strength. All measurements were obtained before and after SMFR.

Results
Repeated-measures analysis of variance indicated that SMFR had a positive effect on RSI (p < 0.01), increasing this performance measure by 20.1 %. HJ showed a similar trend (increasing 12.8 %) but was not significant. CT did not see a change post SMFR (p = 0.76).

Conclusion
From a training perspective, the results indicated the use of SMFR as an integrated part of the warm-up as thirteen out of fourteen subjects either maintained or increased performance after SMFR. Furthermore, as CT did not change while HJ had a noted improvement this clearly offers an insight as to how SMFR affected the jumping mechanics; subjects were able to produce a greater amount of force in the same amount of time after SMFR.

Morphological Change of Muscle-Fascia Juncions of Transversus Abdominis in Asymptomatic Participants – a Dynamic Ultrasonographic Study

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Background
The transversus abdominis (TrA) is the deepest abdominal muscle which is connected to the lumbar spine via thoracolumbar fascia [1]. Patients with chronic low back pain demonstrated a deficit in the performance of the TrA. Previous studies focused on measuring sliding of the anterior muscle-fascia junction of TrA.
Purpose

This study is to investigate the thickness and sliding of posterior muscle-fascia junction of TrA by establishing (1) the reliability of measuring; (2) the relationship between the anterior and posterior sites of the TrA.

Methods

Asymptomatic participants (n=20) were positioned in hook-lying to perform abdominal drawing-in maneuver (ADIM) viewed in B-mode with 5–12 MHz linear Ultrasound transducer. The outcome variables included the resting thickness (Thr), the thickness during contraction (Thc), ΔT (change of thickness), and ΔX (change of sliding length). Intra-class correlation coefficient (ICC) was used to test the reliability. The relationship between the US measurements of the anterior and posterior muscle-fascia junctions of the TrA were analyzed with Pearson correlation.

Results

Measuring the thickness and sliding of muscle-fascia junction of posterior site of the TrA showed good reliability (ICC[3,3]=0.888–0.978). The correlation between the measurements between the anterior and posterior sites of the TrA were moderate to good (Pearson correlation [r]=0.41–0.74).

Discussion

1) Measuring the musculofascial corset from the posterior site using ultrasonography is reliable; 2) the US measurements at both anterior and posterior sites of the TrA provide comprehensive evaluation to the fascia of TrA.

Reference


Sonographic Structure of the Plantar Fascia is Related to the Viscous Behaviour of Overlying Fibroadipose Tissue

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Background

The thickness of the plantar fascia has been shown to be correlated with regional loading beneath the foot in chronic plantar heel pain [1]. However, loading within the foot is dependant, in part, on the mechanical properties of the intervening plantar tissues. While these highly specialised fibroadipose tissues are hierarchically structured to dissipate impacts associated with weightbearing, little is known about their mechanical properties or their relation to the morphology of deeper foot structures. Consequently, this study employed a novel technique in which a digital fluoroscope was synchronised with a pressure platform, to investigate the mechanical properties of the heel fat pad during walking and their potential relation to the sonographic appearance of the plantar fascia in chronic plantar heel pain.

Methods

Nine individuals with unilateral plantar fasciitis and nine age, sex and weight matched controls participated in the study which received university ethics clearance. The thickness of the plantar fascia in the symptomatic and matched control limbs was acquired using high-resolution ultrasound. Deformation of the plantar fat pad during walking was estimated from dynamic lateral radiographs acquired with a multifunction fluoroscopy unit. Peak compressive load was simultaneously acquired via a pressure platform. Principal structural properties of the heel pad, including stiffness and hysteresis were estimated.

Results

The symptomatic plantar fascia (6.7±2.0 mm) was thicker than the fascia of the matched control (3.3±0.4 mm) fascia.
(P<.05). Although there was no significant between-limb differences in average thickness, peak force, peak deformation or stiffness of the heel fat pad, the energy dissipated by the fat pad of the symptomatic limb (0.55±0.17) was significantly lower than that of the control (0.70±0.09) limb (P<.05). Hysteresis of the fat pad was positively correlated with fascial thickness (r=0.72, P<.05) but only in the symptomatic limb.

Discussion and Conclusion

In plantar heel pain, the elastic properties of the heel pad remained unaltered. However, energy loss within the tissue was lower in symptomatic limbs and was correlated with the sonographic thickness of the plantar fascia. These findings suggest that viscosity, rather than elasticity, of the heel fat pad may play an important role in the severity of heel pain and provides a previously unidentified link between the mechanical behaviour of the plantar fat pad and the morphology of the underlying plantar fascia

Disclosures

Dr Wearing is funded through a Smart Futures Fellowship, Department of Employment, Economic Development and Innovation, Queensland Government.

Reference


4.2.8 Documenting Pressures Used for Manual Diagnosis and Treatment of Cervical Spine Somatic Dysfunction

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Background

Palpatory assessment of free or restricted motion patterns is part of the diagnosis of spinal somatic dysfunction (SD). Diagnostically, local soft tissues are compressed (pre-loaded) over the structure of interest followed by one or more test impulses to assess the quality of the “end-feel” motion in several planes. These barrier sensations are often described qualitatively but have not been objectively quantified. Noninvasive, tactile pressure sensors built into a digital palpation monitoring system (IsoTOUCH®; Neuromuscular Engineering; Nashville TN, USA) were used to document loading and impulse pressures for palpatory segmental diagnosis and to first engage and then quickly move through a restrictive SD barrier using an osteopathic manipulative treatment (OMT) technique.

Materials & Methods

Subjects were monitored using the IsoTOUCH® to measure representative force levels used during cervical spinal palpatory diagnosis and High Velocity Low Amplitude (HVLA) OMT of SD identified at the occipitoatlantal (OA) articulations specifically. Measurements included diagnostic pressures (preload and end-feel forces used to assess functional and restrictive barriers), and OMT pressures (preload and thrust applied during HVLA to correct SD). Within a few minutes pre- and post-OMT, a second, blinded physician objectively quantified segmental tissue texture (hysteresis) characteristics using a durometer (Spineliner®; Sigma Instruments, Pittsburg PA, USA). 25 out of 31 subjects were then treated by the same osteopathic neuromusculoskeletal medicine specialty physician (MLK) with a single, direct-method HVLA technique to the OA. With the occiput in slight loose-pack flexion regardless of any sagittal plane diagnostic component, preload pressure to the barrier was applied primarily with lateral translation and side-bending. Each corrective HVLA curvilinear force (introduced primarily through a single fingertip placed over the occiput) was directed at the SD barrier towards the opposite orbit.

Results

Of 31 relatively asymptomatic subjects all with OA SD, 28 were diagnosed as preferring side-bending right, rotation
left and 3 with side-bending left, rotation right. Overall diagnostic palpatory pressures (OA-C7), preload pressures averaged 1.35 lbs (95% CI=1.31–1.40 lbs; p<0.001) and end-feel pressures averaged 2.64 lbs (95% CI=2.56–2.72 lbs; p<0.001), or about 1.31 lbs difference between preload and end-feel pressures (p<0.001).

Overall treatment pressures for the OA averaged 2.89 lbs pre-load (95% CI= 2.42–3.35 lbs; p<0.001), 4.05 lbs final thrust level (95% CI=3.53–4.57 lbs; p<0.001), and an actual HVLA activating force averaging 1.10 lbs (95% CI=0.83–1.36 lbs; p<0.001).

During OMT, audible cavitations were appreciated in 80% of subjects. Post-OMT palpatory motion improvement was noted by the treating physician in 84% and independent durometer improvement of tissue texture changes for fixation (resistance) was appreciated in 80%. No change was noted in 12%.

Conclusion

In this population, intraoperator palpatory pressures used in cervical diagnosis were fairly consistent (averaging 1.35 lbs tissue loading with an additional 1.31 lbs to assess barrier end-feel.) Intraoperator OMT parameters using a singular form of HVLA to correct OA SD were also fairly consistent (employing an additional fractional-second force averaging 1.10 lbs focused over occipital tissues preloaded with less than 3.5 lbs of pressure.) Documenting the pressures used in manual diagnosis and treatment should permit other researchers and clinicians to reproduce those techniques described in the expanding evidence-base for these modalities and perhaps aid those wishing to enhance their manual skills.

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Thoracolumbar Fascia Shear Strain Induced by Acupuncture Needling in Human Chronic Low Back Pain

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Background

The thoracolumbar fascia is composed of several layers of dense connective tissue separated by layers of “loose” areolar connective tissue that allow adjacent dense layers to glide past one another. Independent motion of adjacent connective tissue layers is particularly relevant in structures such as the thoracolumbar fascia in which the dense layers correspond to aponeuroses of muscles with different directions of pull: in this case, longitudinal for latissimus dorsi, serratus posterior and erector spinae and transverse for internal/external obliques and latissimus dorsi. We have recently shown that, in humans during passive whole trunk flexion, shear strain within the thoracolumbar fascia is reduced in human subjects with chronic LBP of more than 12 months duration (Langevin 2011 BMC Musculoskeletal Disorders). Possible explanations for this finding include abnormal patterns of trunk muscle activity and/or intrinsic connective tissue pathology such as chronic inflammation and fibrosis. Measurement of thoracolumbar shear strain induced by a more localized mechanical perturbation would provide evidence toward discriminating between these possibilities. Acupuncture needles provide useful probes that specifically interact with connective tissue. During acupuncture needle rotation, collagen winds around the needle, creating a mechanical bond between needle and connective tissue. Subsequent oscillation of the needle induces highly localized perturbations within the connective tissue layers. We hypothesized that the shear strain between tissue layers induced by acupuncture needle oscillation could be measured using ultrasound elastography techniques.

Methods

We conducted a pilot study in which thoracolumbar shear strain was measured during robotic acupuncture needling in 34 human subjects (17 with LBP for more than one year and 17 without LBP). A robotic acupuncture needling instrument (Stromaglide, Stromatec, Inc, Burlington VT) was used to insert the needle at a fixed 20° angle to the ultra-
sound transducer, 1 cm beyond the superficial border of muscle (verified by ultrasound). After insertion, the needle was rotated at 360 degrees/sec to either a torque of 100 μNm or ten revolutions – whichever came first. Following rotation, the needle was oscillated for 5 cycles at 5 mm amplitude and rate of 5 mm/sec). An ultrasound cine-recording was acquired during the rotation-oscillation sequence at 25 frames/sec. Ultrasound raw frequency data was processed for lateral displacement using elastography cross-correlation techniques within a region of interest 2 mm superficial and deep to the perimuscular connective tissue. The echolucent plane separating the echogenic sheet closest to the muscle from the echogenic structure immediately superficial to it was identified and two sub-regions of interest (sub-ROIs) were defined respectively 1 mm superficial and deep to that plane. For calculation of shear strain, the superficial and deep sub-ROIs were divided into four Zones (A, B, C and D), with A being furthest away from the needle.

Within each zone, the shear strain was calculated as the difference in lateral displacement between the superficial and deep Sub-ROIs expressed as a percentage of the axial distance between the Sub-ROI centers. Thoracolumbar shear strain was calculated as the cumulative shear strain over 5 oscillation cycles, averaged per cycle.

Results

Among all subjects tested, thoracolumbar shear strain was measurable and ranged (mean ±SD) from 11.4±8 % in zone D (immediately next to the needle) to 4.1±3 % in zone A (4 cm away from the needle).

Conclusion

Measurement of thoracolumbar shear strain is feasible using a combination of robotic acupuncture and ultrasound elastography. Further analyses will examine differences between LBP and No-LBP groups.

Disclosures

RD is a shareholder and CEO of Stromatex, Inc, the medical R&D company that developed the Stroma Glide measurement tool. This tool may eventually be available for sale commercially. The device development and the project reported in this abstract were fully underwritten by NIH SBIR grant 1R43AT006085--01 from the National Center for Complementary and Alternative Medicine.

Effect of Trunk and Hindlimb Movement Restriction on Paravertebral Connective Tissue in a Rodent Model Using Magnetic Resonance Imaging

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Background

We have recently shown that human subjects with low back pain for more than 12 months had a 25 % increase in the ultrasound echogenicity of lumbar paravertebral connective tissue compared with subjects matched for age, sex, and body mass index, as well as a 25 % reduction in shear strain within the thoracolumbar fascia during passive trunk flexion. We have proposed that connective tissue remodeling is an important component of the pathophysiology of chronic low back pain. This abnormal structure and function of connective tissue may be due in part to movement restriction that could be contributing to the cause or the effect of low back pain. We hypothesize that connective tissue remodeling can be induced experimentally in rats using a non-surgical method for restricting trunk and hindleg motion.

Methods

31 rats were randomized to full movement restriction (N=12) vs. partial movement restriction (N=11) vs. no movement restriction (N=8). Full movement restriction was achieved using a “hobble” device consisting of a metal collar surrounding one ankle and a chest harness, both connected by a chain resulting in a 50 % reduction of the standing distance between the forefoot and ipsilateral hind-
foot. Partial movement restriction consisted of the foot collar and chest harness without the connecting chain. Animals without movement restriction had no foot collar or chest harness. Rats wore the devices, or no device for 8 weeks. Both full and partial devices allowed the rats to ambulate while restricting trunk and hindleg motion to different degrees. Because the rate of weight gain over the 8 weeks was slower in the full and partial restriction groups compared with non-restricted controls, the controls were food-restricted to maintain balanced body weights across experimental groups. At the end of 8 weeks, gait analysis was performed using walking tracks left by paint applied to the rats’ hindfeet. Following gait analysis, the rats were euthanized and the paravertebral connective tissue of the back was examined with magnetic resonance imaging (MRI), ultrasound and histology. Preliminary measurements were made of the average cross sectional area of connective tissue in transverse MRI images including 1.5 cm on both sides of the midline, from the L6–S1 to the L3–L4 interspaces.

Results

The full movement restriction device decreased the intrastep distance \( p=.05 \) compared with no device. While the partial movement restriction device did not significantly decrease the intrastep distance compared with no device, there was a decreasing trend similar to that found for the full movement restriction device. In preliminary measurements, connective tissue cross sectional area was increased in both full \( p=.013 \) and partial \( p=.025 \) movement restriction groups compared with non-restricted controls. Mean ±SE cross sectional areas were 27.2±0.9 mm\(^2\), 26.8±1.0 mm\(^2\), and 23.5±0.7 mm\(^2\) respectively for full, partial, and no movement restriction groups. Further analyses and experiments are currently underway to investigate the effect of the full and partial devices on connective tissue (using ultrasound and histology) as well as possible stress induced by the devices (using an open field behavioral test).

Conclusion

Preliminary results suggest that movement restriction can influence the thickness of connective tissue in the back. Further testing will be necessary to determine what component of movement restriction (foot collar, chest harness, and/or generalized stress) induced the thickening of paravertebral connective tissue in this experimental model.