Effect of 3-d torque and muscle splay techniques on subjects with Posterior tibial tendon dysfunction: A comparative study.

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ABSTRACT
Study objectives: To compare the effectiveness of two less commonly used techniques of MFR namely 3-D Torque and Muscle Splay.
Design: A comparative study
Setting: All the Subjects were taken from different hospitals, rehabilitation centres, NGOs and community in and around Dehradun
Subjects: A total of 15 subjects (M: 12, F: 3) were recruited for the study on the basis of inclusion and exclusion criteria after signing the informed consent form.
Measurements: pain was measured using VAS, disability was assessed using FADI and inversion ROM of subtalar joint was measured using goniometer.
Results: Within group comparison showed significant changes with improvement in Pain, Disability and Subtalar ROM in both Group A and B with group A showing lower mean values for VAS compared to Group B post-intervention. However, Group B demonstrated higher values of Subtalar inversion ROM and higher FADI scores post-intervention.
Conclusions: The present study concluded that both the techniques that is 3 D Torque and Muscle splay are equally effective in reducing pain and disability and improving ROM (Inversion) in subjects with Posterior Tibial Tendon Dysfunction.
KEY WORDS: Tibialis Posterior, Posterior Tibial Tendon Dysfunction, Myofascial Release, 3 D Torque, Muscle Splay.

INTRODUCTION
Posterior Tibial Tendon Dysfunction (PTTD) is a progressive and debilitating condition. PTTD is a common running-related injury. While the etiology of PTTD has not been established, it is considered multi-factorial in nature and has generally been related to progressive alterations in arch structure, muscular strength, and gait biomechanics.1

Posterior Tibial Tendon Dysfunction is the major cause of acquired flatfoot deformity in adults. The later stages of the disorder are characterized by increased heel valgus, plantarflexion of the talus, flattening of the medial longitudinal arch, and abduction of the forefoot at Chopart's joint. Posterior Tibial Tendon Dysfunction includes a broad range of progressive disorders, ranging from tenosynovitis to tendon rupture with or without hind foot collapse to a fixed, rigid, flatfoot deformity. The causes of Posterior Tibial Tendon Dysfunction are varied. They include age-related degeneration or overuse with attenuation, chronic recurrent tenosynovitis, inflammatory arthritis, and infrequently acute traumatic rupture. The classification scheme in current use, places subjects into 3 stages depending on symptoms and degree of deformity. Subjects with stage I PTTD present with signs of tendinopathy without foot deformity, while stage II disease presents with both signs of tendinopathy and flexible flatfoot deformity. In stage III PTT deformity is fixed. Recent reports suggest that the flexible flatfoot deformity in subjects with stage II PTTD includes a lower medial longitudinal arch (MLA) height, excessive hindfoot (HF) eversion, and excessive forefoot abduction in stance.7

The etiology of Tibialis Posterior insufficiency ranges from inflammatory synovitis (leading to degeneration, lengthening, and rupture) to acute trauma. Holmes and Mann reported that 60% of those who suffered a Tibialis Posterior rupture had a history of obesity, diabetes, hypertension, previous surgery or trauma to the medial foot, or previous treatment with steroids. Acute traumatic Tibialis Posterior rupture is very rare. In the early stages of PTT insufficiency, most patients complain of fatigue, aching, and pain of the plantar-medial aspect of the foot and ankle just proximal to the tendon insertion onto the navicular tuberosity. Discomfort is located medially along the course of the tendon. Swelling or bagginess along the tendon is common if the
Dysfunction is associated with tenosynovitis. Pain is exacerbated by activity, weight-bearing, and calf raise. The patient's ability to walk distances usually decreases. Both feet should be examined with the patient standing and both lower extremities entirely visible. The too-many-toes sign as described by Johnson (1983) should also be looked for from behind the patient: abduction of the forefoot relative to the hindfoot allows more of the lateral toes to be seen on the symptomatic foot than on the unaffected foot. Patients with early (stage 1) PTTD may have only swelling and tenderness medially. As the insufficiency progresses, the longitudinal arch collapses. Hindfoot valgus is initially flexible (hindfoot correctable to subtalar neutral) and eventually becomes fixed. The single limb or "unilateral" heel raise should be attempted while the patient is standing. With dysfunction of the PTTD, inversion of the heel is weak, and the patient is unable to rise onto the forefoot or the heel remains in valgus rather than being swung into varus on heel raise.

Myofascial Release (MFR) technique is a facilitation of mechanical, neural and psycho-physiological adaptive potential as interfaced via the myofascial system. The term Myofascial Release as a technique was coined in 1981, when it was used as the title of the first soft tissue release courses taught at Michigan State University in the fall of that year. Both indirect and direct Myofascial Release concepts were introduced in 1981. Myofascial procedures vary significantly, ranging from prolonged stretching to and soft tissue mobilization to subtle indirect techniques. It is a highly interactive stretching technique that requires feedback from the patient’s body to determine the direction, force and duration of stretch and to facilitate maximum relaxation of tight and restricted tissues.

**MATERIAL AND METHODS**

**Sample:** A total of 15 subjects (M: 12, F: 3) were recruited for the study on the basis of inclusion and exclusion criteria after signing the informed consent form.

**Design:** comparative study

**Instrumentation**

- Universal Goniometer Fig 4.1
- Foot and Ankle Disability Index
- Body Marker

**Procedure:**

**Pre-intervention measurement:** Procedure for measurement of Subtalar Inversion ROM: The subject assumed a prone position with the foot and ankle (to be measured) hanging over the end of the tabletop. A narrow vertical line was drawn on the posterior lower leg using a body marker. The line should be midway between the medial and lateral borders. To locate the medial and lateral heads of the talus, the following guidelines were proposed: 1) The medial aspect of the head of the talus is slightly inferior and anterior to the medial malleolus.
and proximal to the navicular and 2) the lateral aspect of the head of the talus is anterior to the lateral malleolus (toward the midline of the foot. To place the foot in the Subtalar joint Neutral (STJN) position, the therapist placed the thumb of the medial hand under the medial aspect of the head of the talus and the index finger over the lateral aspect of the head of the talus. The STJN position is that position where the therapist is able to palpate the head of the talus equally, both medially and laterally. The STJN position was maintained, and the goniometer was used to take measurement. Fig 4.2

Inclusion Criteria

- Diagnosed cases of PTTD Pre-stage 0 and stage 1 based on assessment chart
- Age between 18-29 years
- Both Genders

Exclusion Criteria

- No swelling and tenderness over the Posterior Tibial tendon
- Signs of Plantar Fascitis and heel pain
- Heel pad contusion
- Deformities or contractures affecting normal ROM of ankle joint
- History of Systemic muscle disease
- Neurological condition involving the Lower Limb
- Surgery Lower Limb in past 2 years
- Calcaneal fractures
- Any Musculoskeletal Injury which limits the application of MFR
- Previous Physiotherapy treatment in past 6 months around ankle
- Shoe modification in last 3 months

The goniometer was aligned with the fulcrum of the goniometer over the posterior aspect of the ankle midway between the malleoli, the proximal arm was aligned with the posterior midline of the lower leg, and the distal arm with the posterior midline of the calcaneus. For the Testing Motion the subject’s lower leg was held with one hand and other hand will pull the subject’s calcaneus medially medially into adduction and subtalar inversion. Fig 4.3 & 4.4
Procedure for intervention: Subject in group A were administered MFR in the form of 3-D Torque and the subjects in Group B were administered MFR in the form of Muscle Splay. Foot exercises were administered to all the subjects of both groups.

Procedure for 3-D Torque: Patient was positioned prone with hip neutral and knee flexed 20 degrees and resting on a pillow. The therapist stood besides the treatment table at the leg end facing the target bulk was
located and hands placed above & below site. The hand placed superiorly pulled the muscle belly towards therapist’s own body and other hand pushed the belly away from the therapist’s body Fig 4.5

**Procedure for Muscle Splay:** Patient was positioned prone with hip neutral and knee flexed 20 degrees and resting on a pillow. The therapist stood besides the treatment table at the leg end facing the patient. The hands gently grasped the middle aspect of the leg so the thumbs are in contact with the distal portion of the calf. The thumbs approximate one another at the medial aspect of the leg deep pressure is applied medially by the thumbs, as the calf is stroked longitudinally from proximal to distal. As the distal portion of the calf is reached, the direction of stroke was changed from medial to lateral, splaying or pulling the calf muscles apart. Fig 4.6
**Procedure for foot exercises**: three weight-bearing exercises will be performed: Toe raises, Toe curls and Quarter squats. Fig 4.7, 4.8, 4.9
Post intervention measurement for measurement of subtalar ROM, navicular drop and pain and disability will be taken after a period of 2 weeks the procedure will be the same as followed for pre intervention assessment.
Protocol
3-D Torque: 10 repetitions of 1 minute hold and 30 seconds rest for 15 minutes per day for 6 days a week for 2 weeks
Muscle Splay: 10 repetitions of 1 minute hold and 30 seconds rest for 15 minutes per day for 6 days a week for 2 weeks
Foot exercises: 10 repetitions of each exercise with 1 minute rest between sets, per day for 6 days a week for 2 weeks.

Operational Definition
Posterior Tibial Tendon Dysfunction

Stage 0 (Pre-Stage 1)
Pre-Stage 1 is characterised by complain of immediate heel pain on weight-bearing in the morning, increased load from activities increase pain which decreases during the day, Weight-bearing ankle plantar flexion (heel raising) lacks full range of motion and Tibialis posterior length test shows decreased extensibility and often reproduces heel pain.

Stage 1
Stage 1 is characterised by complain of ache along the medial aspect of the ankle, and indicates discomfort along the tendon, exacerbated by physical activity. Tenderness and swelling is detected, the hindfoot is in a normal or slightly everted but flexible and Tibialis posterior length cannot be tested due to pain.

DATA ANALYSIS
Data was analysed using statistical package of social sciences SPSS software (version 14.0). Wilcoxon Signed Rank Test was applied to compare the means of VAS, FADI and ROM of Inversion scoring of pre-intervention and post-intervention within groups. Mann-Whitney test was applied for mean comparison of pre and post intervention readings of both interventions. The p value was set at (<0.05)

RESULTS
The changes observed in this study were note worthy. Within group comparison showed significant changes with improvement in Pain, Disability and Subtalar ROM in both Group A and B with group A showing lower mean values for VAS compared to Group B post-intervention. However, Group B demonstrated higher values of Subtalar inversion ROM and higher FADI scores post-intervention. But statistically non-significant improvement in the readings of VAS was observed in Group A and statistically non-significant improvement in the readings FADI and Subtalar ROM Inversion was observed in Group B when

Mean and SD of age for Group A and Group B are
36.750 ± 11.053 and 38.00 ±11.674 (Table & Fig 5.1)

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<th>Demographic</th>
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Table 5.1. Shows the demographic data of Mean and SD of age for Group A for Group B
Table & Fig 5.2 shows mean and SD of VAS at pre and post 2 weeks after treatment. The score of Group A on 1st and 14th days were 6.125±1.457 and 4.375±1.598. The score for Group B on 1st and 14th days were 6.428±1.40 and 4.71±0.488. This data suggests a statistically non-significant improvement in pain during follow up days in both groups.

<table>
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Table 5.2: Comparison of Pre and Post VAS Score for Group A and B
Table & Fig 5.3 shows the mean and SD of FADI at pre and post 2 weeks after treatment. The score of Group A on 1st and 14th days were 53.125±15.469 and 65.625±11.551. The score for Group B on 1st and 14th days were 43.714±20.345 and 71.571±6.877. This data suggests a statistically non-significant improvement in disability during follow up days.

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Table 5.3: Comparison of Pre and Post FADI Score for Group A and B
Table & Fig 5.4 shows the mean and SD of Inversion ROM at pre and post 2 weeks after treatment. The score of Group A on 1st and 14th days were 23.886±10.743 and 25.73±9.813. The score for Group B on 1st and 14th days were 24.131±8.300 and 26.024±6.760. This data suggests a statistically significant improvement Inversion ROM in during follow up days.

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Table 5.4: Comparison of Pre and Post Inversion ROM for Group A and B
Table 5.5 shows the mean and SD of VAS at pre and post 2 weeks after treatment. The scores of Group A and Group B on 1st day were $6.125 \pm 1.457$ and $6.429 \pm 1.398$ respectively. The scores of Group A and Group B on 14th day were $4.375 \pm 1.598$ and $4.714 \pm .488$ respectively. This data suggests a statistically non-significant improvement VAS Group B during follow up days.

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Table 5.5: Comparison of Pre and Post VAS Score between Group A and B
Table & Fig 5.6 shows the mean and SD of FADI at pre and post 2 weeks after treatment. The scores of Group A and Group B on 1st day were 53.125±15.469 and 43.714±20.345 respectively. The scores of Group A and Group B on 14th day were 65.625±11.551 and 71.571±6.877 respectively. This data suggests a statistically non-significant improvement FADI Group B during follow up days.

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Table 5.6: Comparison of Pre and Post FADI Score between Group A and B
Table & Fig 5.7 shows the mean and SD of Inversion ROM at pre and post 2 weeks after treatment. The scores of Group A and Group B on 1st day were 23.886±10.7843 and 24.131±8.3002 respectively. The scores of Group A and Group B on 14th day were 25.730±9.8135 and 26.024±6.7607 respectively. This data suggests a statistically non-significant improvement Inversion ROM Group B during follow up days.

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Table 5.7: Comparison of Pre and Post Inversion Rom between Group A and B
DISCUSSION

The present study investigated the effect of two MFR Techniques namely, 3-D Torque and Muscle Splay on Posterior Tibial Tendon Dysfunction. Pain, Disability and ROM of Subtalar Joint was measured 2 times: pre-intervention and post-intervention through Visual Analogue Scale (VAS), Foot and Ankle Disability Index (FADI) and Subtalar Joint Inversion Goniometric Measurements respectively. We found that there are no significant differences between Groups A and B in terms of improvement in Pain, Disability and Subtalar ROM.

The probable reason for the similar improvement in both groups may be that although both techniques are different in terms of application, their mechanism of action is similar and is in line with the overall myofascial therapy mechanism. Myofacial Therapy represents a philosophy of care, rather than a series of techniques. A hallmark of most Myofacial work is the attempt to entrain the patient and clinician in such a way as to permit the patient response to manual contact to facilitate the treatment. Myofacial release is the interactive stretching techniques that require feedback from the patient’s body to determine the direction, force and duration of the stretch and to facilitate maximum relaxation of tight or restricted tissue.

MFR applied to a muscle increases the discharge from the GTOs and elicits inhibition of any further tensioning in that muscle. The Ruffini bodies respond to slow and deep melting techniques. Furthermore, the stimulation of the Ruffini bodies is linked to a reduction in the activity of the SNS. This certainly helps in understanding the effects of soft tissue manipulation on the ANS that were described earlier where both local and systemic changes in that system occur. Gamma neurons can be inhibited by supraspinal structures. The medial reticular formation plays a role in this inhibition. When certain forms of stimulation provided by an MFR practitioner, the interstitial fibres signal the blood vessels to increase the renewal speed of the ground substance. Hydration may occur but it is initiated through sensory fibres rather than mechanical force alone. An increase in the quantity of ground substance helps maintain the interfiber distance and lubricates the space between the fibres. This is fascial cohesiveness – the affinity of fibers that drives them to bind with their neighbours is balanced via an appropriate volume of ground substance.

Using electron photomicroscopy, two researchers observed not only widespread existence of the intrafascial nerve fibers mentioned above but also, unexpectedly, smooth muscle cells (El Dorado). With smooth muscle cells being under the control of the ANS, it seems likely that neural-regulated tensioning occurs within fascia. This fascial tonus is controlled via the state of the ANS, separate but related to the much stronger tonus regulation of muscles via the neuromuscular system. MFR has been shown to reduce the severity of this tuning and increase the activity of the vagus nerve.

Fig 5.7: Comparison of Pre and Post Inversion Rom between Group A and B
The 3 D Torque is applied in case of Myofascial restrictions that limit hyperextension, diagonal, or rotational movement patterns. In this technique the target bulk is located and hands are placed above & below site. The hand placed superiorly pulls the muscle belly towards therapist’s own body and other hand pushes the belly away from the therapist’s body. Treatment in Three Dimensions allows access to the deeper layers that contain the original soft tissue injury. Treatment in Three Dimensions becomes a fluid and dynamic dance between the patient and the therapist as one stretch-and-release sequence leads directly into the next. The proposed mechanism of influence of 3 D Torque on tissues is to facilitate patient’s inherent ability to correct soft tissue dysfunction that is source of patient’s pain complain. This facilitatory correction in soft tissue dysfunction may have lead to reflex improvement in pain. The results of present study support this mechanism. We found improvement in VAS, which may have been caused by the release of target muscle Tibialis Posterior. The reduction in pain was not concurrent with decrease in disability as the outcome measure we used tested mostly functional activities. PTTD patients’ exhibit altered rearfoot kinematics throughout the entire stance phase of gait due to greater rearfoot eversion that is associated with PTTD. Thus the functional outcome is affected, hence the reduction in pain did was not associated with simultaneous improvement in disability.

Muscle splay involves gently grasping the muscle belly and applying pressure is by the thumbs splaying or pulling the calf muscles apart. Muscle splay utilizes light touch which in accordance with Arnlt-Schulz Law is known increase physiologic activity and encourages the release of asymmetrical soft tissue soft tissue stress and leads to reflex relaxation of tissues both proximal and distal to treatment site. This mechanism of tissue relaxation leads to resetting of muscle spindle and new resting position in anatomic neutral occurs. This release of target muscle Tibialis Posterior may lead to improvement in Inversion ROM. The results of present study support this mechanism, whereby the relaxation of Tibialis Posterior muscle may have lead to improvement in Inversion ROM scores. Patients with PTTD group exhibited greater peak eversion while walking and approximately 4° less inversion at heel strike. An improvement in Inversion ROM thus will improve heel position at heel strike and lead to better functional outcomes during walking. This is supported by the results of present study where improvement in Inversion ROM in Group B is associated with concurrent reduction in disability.

Although we did found improvement in pain and disability in Muscle Splay Group and improvement in ROM (Inversion) in 3 D Torque Group, when comparison was done between the groups we did not come across any significant difference for any of the parameters which leads us to believe that although there are differences in the application of 3 D Torque and Muscle Splay techniques, their overall mechanism of action appears to be more or less similar. Other factors which may have been a reason for the results could be lack of quantification of difference in amount of force application during both the techniques and the small sample size which affected the study’s ability to differentiate between the two techniques. May be a study with larger sample size would be more effective in differentiating between two techniques.

CONCLUSION
The present study concluded that both the techniques that is 3 D Torque and Muscle splay are equally effective in reducing pain and disability and improving ROM (Inversion) in subjects with Posterior Tibial Tendon Dysfunction.

REFERENCES