



Research article

**EFFICACY OF ECCENTRIC EXERCISES WITH THERAPEUTIC ULTRASOUND
FOR THE MANAGEMENT TENDO
ACHILLES TENDINITIS AMONG ELITE**

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Abstract

The main purpose of the study was to determine which treatment regime of tendon rehabilitation produced a more effective result in terms of recovery in the treatment of Achilles tendonitis. In the present study, patients with painful Achilles tendinosis at the 2-6 cm (length) level in the tendon were randomized to the treatment with combined efficacy of eccentric training regimen for the calf muscles with therapeutic ultrasound. The proposed study included 30 elite athletes in a single group study with the mean age 30 years) in the intervention group. The amount of pain during physical activity (jogging or walking) was measured with visual analogue scale, patient satisfaction with the treatment, pain reduction, Range of motion and FAAM was assessed baseline to post treatment. The athletes were instructed to perform their eccentric training regimen on a daily basis of 45 minutes for 3 months. In both types of treatment regimen the patients were told to do their exercises despite experiencing pain or discomfort in the tendon during exercise. The results showed that after the eccentric training regimen 80% of the patients (24/30) were satisfied and had resumed their previous activity level (before injury), with therapeutic ultrasound as the common treatment modality. The results of means of pain, range of motion and FAAM were (0.902), (0.042) and (0.311) $p < 0.05$ respectively, the statistical data concludes that, the participants who had undergone eccentric training program with ultrasound showed significant reduction of pain and performance enhancement for the management of Tendo Achilles Tendinitis among Elite Athletes.

Key wards: Rehabilitation, Achilles tendinosis, Elite athletes and Eccentric Training.

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INTRODUCTION

Achilles tendon pain is manifested as a localized painful thickening of the tendon; it is relatively injured common among middle aged active and recreational elite athletes. Injury to the Achilles tendon or its surrounding sheath and para tendon can be due to overuse, improper training, gait abnormalities, age-related degenerative changes, and improper footwear. Overuse injury of the Achilles tendon commonly occurs in active individuals and those who subject the tendon to repetitive forces beyond its ability to heal (Alfredson et al., 1999). This injury has been noted in all types of athletes, not just runners. Individuals who regularly engage in jumping activities and who subject the tendon to forces (repeatedly) that may be of normal magnitude or the forces that are more frequently applied may increase the grades of the injury (Clement et al., 1984). Disorders of the Achilles tendon rank among the most frequently reported overuse injuries in the evidence based literature. The majority of those suffering from Achilles tendinopathy are individuals engaged in activity, most often at a recreational or competitive level. Achilles tendonitis has become one of the most common athletic injuries today with retrospective studies of lower limb injuries in runners (Leadbetter et al. 1992).

Tendonitis is a painful inflammatory reaction due to overuse

activities involving the tendon. Its course may be acute and self-resolving, or it may become chronic in nature resulting in progressive disability which leads to weakening of the tendon. The etiology of Achilles tendonitis is still not fully understood a myriad of treatment regimens have been advocated with both conflicting and less than rewarding results.

The athlete's degree of disability was diagnosed and established by sports medicine doctor and physiotherapist, a thorough knowledge of the natural history and disease progression of Achilles tendonitis is crucial for the rehabilitative procedure. Tendonitis in general, Achilles tendonitis being no exception, has long proven to be very resistant to conservative treatment (Ames et al., 2008). Conservative treatment consists of modalities that include extended periods of (PRICE) rest, ice, anti-inflammatory drugs, electrotherapy, orthotics, and cast immobilization. When these methods fail, sometimes surgery is performed. Although these treatments may relieve symptoms, recurrence is common unless the basic causes of the problem are dealt with - either an Achilles tendon too weak to do what is demanded of it or biomechanical factors placing more stress on the tendon than it could normally absorb (Carr AJ and Norris SH .1989).

There is sufficient current evidence to show that inactivity actually weakens the tendon structure. Thus, while

rest or surgery (which is inevitably followed by rest) may succeed in relieving symptoms in some cases, these are not the treatments of choice. A vicious cycle begins, with rest weakening the tendon so that symptoms recur as soon as activity is resumed. Eventually any vigorous physical activity provokes symptoms. In cases of acute tendonitis, where pain is so intense, as to prevent athletic participation, complete rest be enforced and then only until the acute symptoms subside.

It has become evident that the most likely etiology of Achilles tendonitis is forces that are generated very rapidly or repeatedly, as during athletic participation, that may exceed the maximal tensile strength of the actual tendon, and cause microscopic lesions in the tendon tissue. Therefore, it is a goal in any therapy program to enhance muscular strength through hypertrophy and thereby strengthen the tendon sufficiently so that imposed athletic stresses do not exceed its tensile capacity (Bjur et al., 2005).

The fundamental requirement for hypertrophy of any tissue is the maintenance of physiological overload on the structure. Muscle can work in three manners: concentrically (when the muscle shortens while it contracts), isometrically (when the muscle length remains constant while it contracts), and eccentrically (when the muscle lengthens as it

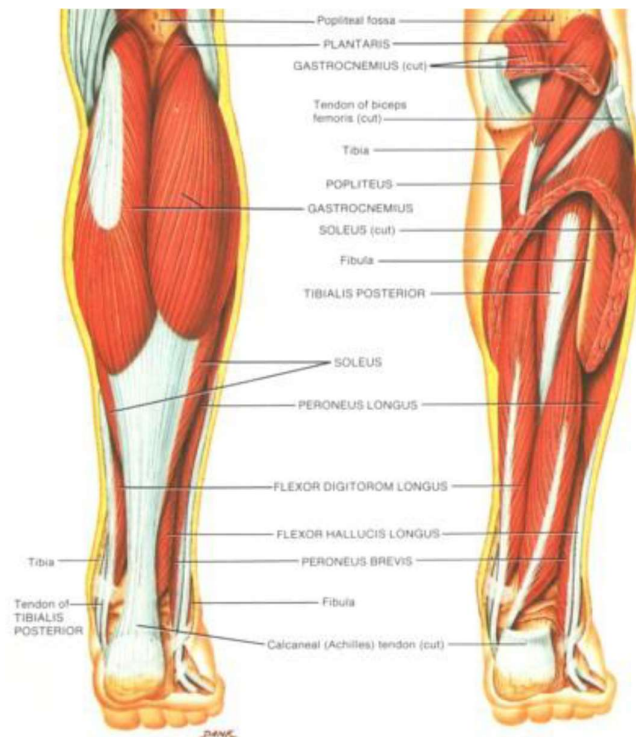
contracts). Whether or not injury occurs to the tendon depends in large part on the magnitude of these forces (Magnussen et al 2009).

The development of the eccentric exercise program was conceived (Maffulli et al. 2003) when traditional treatment methods failed. They found that the traditional stretching, and isometric and concentric exercises that they prescribed did not produce enough tensile force on the tendon. They reasoned that if only by addressing the problem of tensile strength, instability directly would be solved. That is, the tendon must be gradually and progressively overloaded, thereby increasing its tensile strength. They pointed out two reasons why patients should be using eccentric loading: it

1. It simulated actual movements involved in the sport and,
2. It produced more tensile force than other forms of exercise.

ANATOMY

The Achilles tendon is the largest and strongest tendon in the body. The Achilles serves as the conjoined tendon for the gastrocnemius and soleus muscles. On average, the tendon has been reported to be 15 cm in length from the muscle tendon junction to its insertion on the posterior aspect of the calcaneus (Kvist et al .1991).



Of this, approximately half of the tendon is comprised of fibers from the gastrocnemius and half from the soleus. Along its course, the tendon changes shape and orientation. Proximally, the tendon is broad and flat (Kujala et al. 2005). As the tendon descends, however, it takes on more of a rounded stature. With further descent, just proximal to its insertion, the Achilles once again becomes flattened as it broadly inserts

into the posterior surface of the calcaneus. Spiralling causes fibers from the gastrocnemius to become oriented on the posterior and lateral portion of the tendon while fibers from the soleus become located on the anterior and medial portion of the tendon. The tendon is not encased in a true synovial sheath but rather is surrounded by a paratendon, a single cell layer of fatty areolar tissue.

Grades of Tendon Injuries

Grade 1	Pain does not occur during normal activity, but generalized pain is felt in the Achilles tendon about 1 to 3 hours after sport-specific training has ended. Tenderness in the Achilles tendon usually resolves within 24 hours without intervention.
Grade 2	Minimal pain is present in the Achilles tendon towards the end of the sport-specific training session, but performance is not affected. Appropriate treatment may be necessary to prevent a Grade 3 injury.

Grade 3	Pain is present in the Achilles tendon at the onset of training, and interferes with the speed and duration of a training session. Treatment and training modification are necessary to prevent a grade 3 injury from progressing to a grade 4 injury.
Grade 4	Pain in the Achilles tendon restricts training and is also noticeable during activities of daily living; the athlete can no longer continue sport-specific training
Grade 5	Pain in the Achilles tendon interferes with training as well as activities of daily living. The Achilles tendon becomes deformed and there is a loss of function of the triceps surae. [29] Aggressive therapy is required and surgery may be necessary. Conservative therapy is usually successful.

Eccentric Exercise

1. Eccentric calf-muscle loading with the knee straight. From an upright body position and standing with all body weight on the ventral half-part of the foot, with the ankle joint in plantar flexion lifted by the non-injured leg, the calf-muscle was loaded eccentrically by having the patient to lower the heel beneath the lever
2. Eccentric calf-muscle loading with the knee bent. From an upright body position and standing with all body weight on the ventral half-part of the foot, with the ankle joint in plantar flexion lifted by the non-injured leg, the calf-muscle was loaded eccentrically by having the patient to lower the heel beneath the lever
3. Elevating the load by adding weight in a back-pack
4. Elevating the load by adding weight in a weight machine

Objectives of the study

To evaluate the effectiveness of therapeutic ultrasound with eccentric exercises to reduce pain and improve the physical performance of athletes who have grade 2 and grade 3 Tendo Achilles Tendinitis.

METHODOLOGY

Materials and Methods:

Sources of data:

Sports authority of India, Bhopal
Rajeev Institute of Physiotherapy,
Bhopal

Methods of data collection:

Study Design: Randomized study design.
Sample size: Single group 30
Sample Design: Random Sampling

Materials Used:

Ultrasound Modality
Ultrasound Gel
Data collection/Record sheets
Consent form

Cotton
FAAM
VAS scale
Goniometer

Inclusion Criteria:

1. Elite Athletes with Grade 2, grade 3 tendo achilles tendinitis
2. Elite Athletes with the age group between 20-30years
3. Elite Male and female active Elite athletes

Exclusion Criteria:

1. Elite Athletes with post-surgical tendo achilles tendon.
2. Elite Athletes with calcaneal fracture induced tendo achilles tendinitis
3. Any sprain of ankle with tendo achilles tendinitis
4. Any pathology induced tendo achilles tendinitis
5. Any vascular disease induced tendo achilles tendinitis
6. Tendo achilles tendinitis with nerve injury.
7. Foot drop with tendo achilles tendinitis

The participants of the elite athletes who met inclusion and exclusion criteria were considered for the study. The samples collection was done by random sampling procedure. Before under taking the sampling procedure the Intervention of the study which is explained to the elite athletes through their own language understood by them. Informed written consent opinion was received taken from the participants or from their family

members. This study which was approved by appropriate IRB

Therapeutic Intervention Procedure (Ultrasound with Eccentric exercises)

1. Eccentric calf muscle with the knee straight from an upright body position and standing with all the weight on the ventral half of the foot with ankle joint in plantar flexion lifted by the non- injured leg. The calf muscle was loaded eccentrically by having the patient to lower the heel beneath the lever.

2. The calf muscle is eccentrically loaded both with the knees straight and to maximize the activation of the soleus muscle it can also be done with the knees bent.

3. In the beginning the loading consists of the bodyweight, and the patients are made to stand with all their body weight on their injured leg (lifted to that position by the uninjured leg). From an upright body position and standing with all body weight on the forefoot, with the ankle joint in plantar flexion, the calf muscle was loaded by having the patient to lower the heel beneath the lever.

4. They loaded the calf muscle only eccentrically; no concentric loading followed. Instead, the non-injured leg was used to return to the starting position. The patients were told to continue doing the exercise despite experiencing pain during the exercise. However, no training through disabling pain was encouraged. When they were able to perform the eccentric loading without experiencing any minor pain or discomfort, they were instructed to increase the load by adding weight. This could be done easily using a backpack that was successively loaded

with weight). This gradually increases the eccentric calf muscle loading.

The patients were instructed to do their eccentric exercises daily, 7 days/week, for 12 weeks. During the 12-week training regimen jogging/walking activity was allowed if it could be performed with only mild discomfort and no pain. The patients were instructed to start jogging or walking activity at a slow pace, on flat ground, and for a short distance. Thereafter their activity could be gradually increased if there was no severe pain in the tendon.

Eccentric exercises

Two types of exercises which were used in this study. The calf muscle was eccentrically loaded both with the knee straight and to maximize the activation of the soleus muscle also with the knee bent. Each of the two exercises included 15 repetitions in three sets (3×15 repetitions). The patients were told that muscle soreness during the first 1-2 weeks of training was to be expected. In the beginning the loading consisted of the bodyweight, and the patients were standing with all their body weight on their injured leg (lifted to that position by the uninjured leg). From an upright body position and standing with all body weight on the forefoot, with the ankle joint in plantar flexion, the calf muscle was loaded by having the patient to lower the heel beneath the lever. They loaded the calf muscle only eccentrically; no concentric loading followed. Instead, the non-injured leg was used to return to the starting position.

The elite athletes were told to continue doing the exercise despite experiencing pain during the exercise. However, no training through disabling

pain was encouraged. When they were able to perform the eccentric loading without experiencing any minor pain or discomfort, they were instructed to increase the load by adding weight. This could be done easily using a backpack that was successively loaded with weight. This gradually increased the eccentric calf muscle loading. When very heavy weights were needed, the patients were told to use a weight machine. Therapeutic ultrasound was given to conclude the treatment.

Both the groups are administered ultrasound in the direct contact technique with:

- **1mhz ultrasound modality**
- **0.8-1.0watts/ cm² intensity for 6 minutes.**
- **Ultrasonic gel is used as a coupling media.**
- **Direct contact method**

The subjects are assessed with VAS, FAAM and Ankle ROM measured through goniometer at the end of 1st, 2nd and 3rd month respectively.

Outcome measures

Visual Analogue Scale (V.A.S):

A Visual Analogue Scale of pain is an instrument used to measure the amount of pain a patient feels, according to Journal of Clinical Nursing. The visual analogue scale of pain is usually a 100 mm-long horizontal line, which may contain word descriptors at each end. The patient represents their perception of the amount of pain she feels by marking a horizontal line between two points. The visual analogue scale score is measured in millimeters from the left hand end of the line to the point indicated by the patient.

Foot and Ankle Ability Measure (FAAM)

Foot and Ankle Ability Measure (FAAM) is a self reported tool for individuals with leg, ankle, and foot musculoskeletal disorders. It consists of the 21-item activities of daily living (ADL) and 8-item Sports subscales. The test retest reliability of FAAM is 0.89 and 0.87 for the ADL and Sports subscales, respectively. Along with this the range of motion of the ankle joint will be measured.

Range of Motion [ROM]

The Range of Motion is measured in patients having acute Achilles tendinopathy, the goniometer is the valid tool to assess the range of motion of ankle joint. The purpose of goniometry is to

measure the angle of joint position or range of joint motion. Therefore, a valid goniometric measurement is one that truly represents the actual joint angle or the total Range of Motion. The ankle range of motion can be measured by the way of keeping fulcrum at the lateral malleoli, the mobile arm should be fixed at the lateral border of the foot and the stable arm should be placed parallel to the fibula for recording the ankle Range of Motion. Frequency of the tailored treatment regimen of exercises can be given 3 sets x15 repetitions, daily 7 days a week for 12 weeks

Frequency of ultrasound can be given thrice a week for 6 weeks.

The outcome measurement of VAS, FAAM and ankle Range of motion can be measured at the end of 1st month, 2nd month and 3rd month respectively.

RESULTS

TABLE – 1
Mean and SD values for age of the Intervention

Subject	Mean	SD
N=30	24.167	2.901

TABLE – 2
Repeated measure analysis for pain intensity within the treatment duration

Intervention	Mean	SD	SE	F Value
1 st Month	5.33	1.061	0.194	48.65
2 nd Month	3.57	1.305	0.238	
3 rd Month	2.5	0.974	0.177	

FIGURE 1
Duration Mean Value Pain Intensity

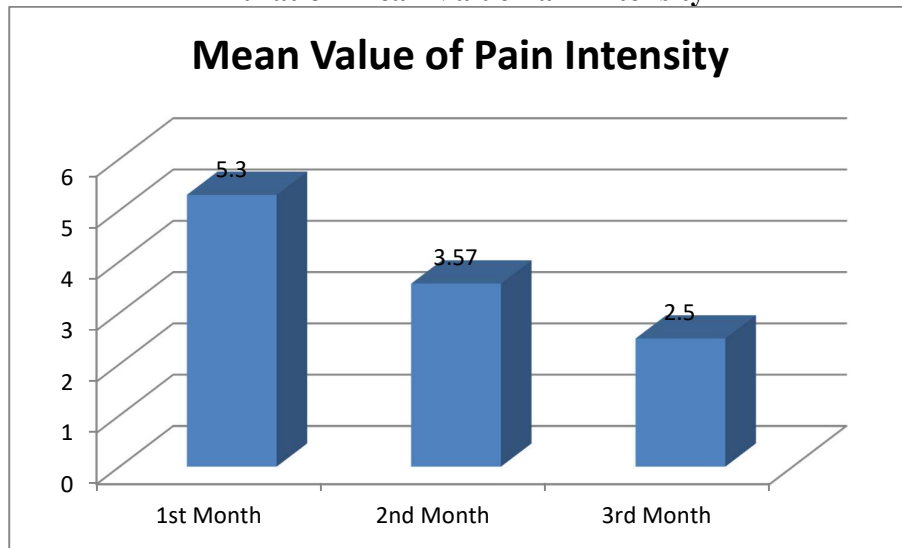


Table 3
Duration mean value ROM

Intervention	Mean	SD	SE	F Value
1 st Month	49.3	2.037	0.372	18.631
2 nd Month	51	1.948	0.356	
3 rd Month	53.4	1.723	0.351	

Figure 2
Duration Mean Value Ankle ROM

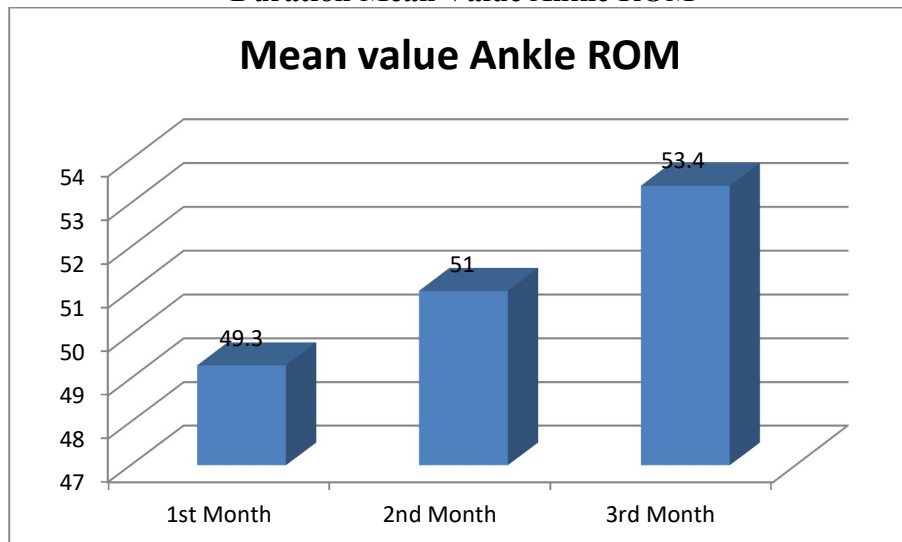
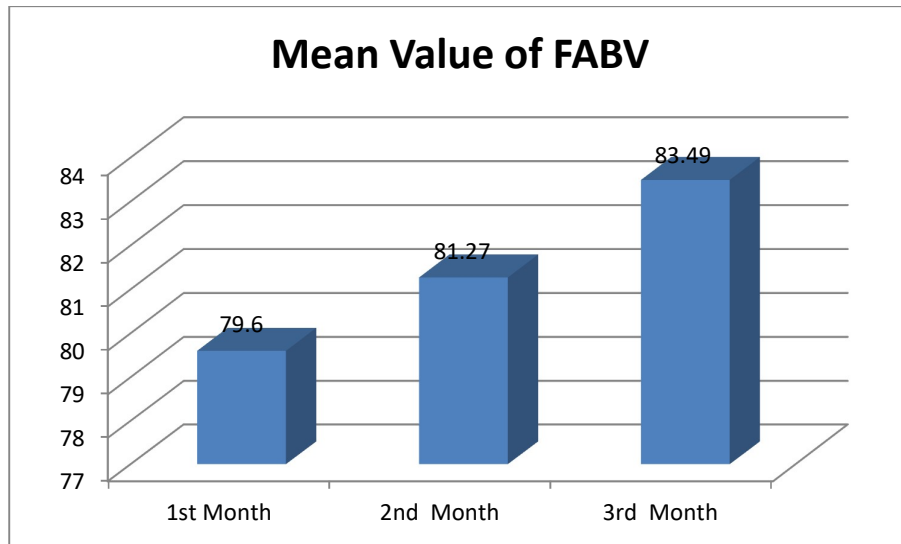


Table 4
Duration mean value FABV

Intervention	Mean	SD	SE	F Value
1 ST Month	79.06	5.635	1.029	3.72
2 nd Month	81.27	5.14	1.006	
3 rd Month	83.49	5.768	1.053	

Figure 3
Duration Mean Value FABV



DISCUSSION

In the earlier research the researchers found that the eccentric training regimen showed better improvement for the management of Tendo Achilles tendinitis (O'Brien 2005). In this research the researcher found that the eccentric training with therapeutic ultra sound treatment regimen produced significantly better results which emphasize specific protocol tendo achilleus conditions.

The forces in eccentric loading are of the same magnitude as seen in concentric loading . This means that force of Achilles tendon's magnitude were

equal in both dorsi flexion and plantar flexion. In the present study the researcher also found that the dorsi flexion and plantar flexion of tendo achilles has same magnitude out of which the eccentric training samples with ultrasound therapy group showed good significant results.

The cause of Achilles tendinosis is known, but the condition is generally associated with overuse from repetitive loading. However, for individuals with a very sedentary life-style may land up with Achilles tendinitis even after a short walks which may cause overuse symptoms of Achilles tendinitis. Achilles tendinosis is most often, but not always,

associated with pain. There has been no first choice of treatment for this condition, but in a recent pilot study treatment with eccentric calf muscle training demonstrated a very good clinical results on patients with Achilles tendinosis located at the 2-6 cm level. The theories of (Saltzman CL, Tarse DS. 1998) on treatment of tendinitis with eccentric exercises, eccentric calf muscle training regimen yielded very good results in a painful chronic Achilles tendinosis at the 2–6 cm level which is tailored treatment strategy eccentric training regimen was used in this study (Kvist M .1994). The clinical examination in this study concluded that the samples had 2–6 cm of Achilles tendon injury.

The single training treatment protocols groups in this study were comparable in respect of the duration of symptoms and the clinical diagnosis. The eccentric exercises were carefully selected for eccentric muscle activation of the Achilles tendon. However, in some of the eccentric exercises there is also some eccentric loading. In both the eccentric training regimen the patients were instructed to experience the pain in the tendon. The patients were instructed to carry out their exercises daily for 3 months.

In this research the author had framed a set of exercises and to see the effect of eccentric exercises for Tendo Achilles tendinitis. Even though the researcher cannot explain why the eccentric training regimen produced significantly better results. Theoretically, it may have been an effect of increased eccentric calf muscle strength, or caused by a lengthening of the muscle-tendon unit and consequently less

load on the tendon during motion. Also, this type of loading (eccentric) may possibly be associated with changes in the metabolism of certain substances in the tendon causing alterations in the pain perception from the tendon.

In this research the mean and standard deviation for pain intensity was assessed with VAS. In the treatment Group the baseline mean and standard deviation of pain intensity was 5.33 and 0.194 whereas at the end of third month (post treatment) the mean and standard deviation of pain intensity was 2.5 and 0.177 respectively. The baseline and the end of third month mean and standard deviation of intervention group showed that, there is statistically significant improvement in the pain intensity. The intervention group samples (eccentric exercises) showed statistically better improvement followed by pain reduction.

In this research the mean and standard deviation for range of motion was assessed with Goniometer. In Intervention group the baseline mean and standard deviation of ROM was 49.3 and 0.372 whereas at the end of third month (post treatment) the mean and standard deviation of ROM was 53.4 and 0.351 respectively. The baseline and the end of third month mean and standard deviation of intervention group showed that, there is statistically significant improvement in the range of motion. The treatment Group samples (eccentric exercises) showed statistically better improvement.

In this research the mean and standard deviation for foot ankle ability measure was assessed. In intervention Group the baseline mean and standard deviation of

FAAM was 79.06 and 1.029 whereas at the end of third month (post treatment) the mean and standard deviation of FAAM was 83.49 and 1.053 respectively. The baseline and the end of third month mean and standard deviation of intervention group showed that, there is statistically significant improvement in the FAAM. The intervention group samples (eccentric exercises) showed statistically better improvement.

The results showed that the tailored approach the treatment of specific protocols yielding the eccentric training regimen 80% of the patients (24/30) were satisfied and the athletes intent to resumed their previous activity level (before injury) and accomplished good performance enhancement.

Limitation

1. Relatively small sample size was taken for the study.
2. No long term follow up was carried.
3. There are few scientific prospective studies, and the absence of studies comparing different types of conservative treatment regimens in a randomized manner is a major disadvantage when evaluating the effects of the specific treatment regimens.

CONCLUSION

The Present study concludes that, the researcher had used tailored treatment strategy protocols especially combined eccentric training program with therapeutic ultrasound which showed significantly pain reduction for the management of Tendo Achilles Tendinitis among Elite Athletes.

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