

Efficacy of Calf Stretching and Achilles Tendon Stretching for the Reduction of Pain and to Improve the Foot Function Disability in Patients with Plantar Fasciitis: Further Observations

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Abstract: ***Background:** Plantar fasciitis is a common foot complication. It is a disorder of the connective tissue which supports the arch of the foot. It causes pain in the heel and bottom of the foot that is usually most severe with the first steps of the day or following a period of rest. **Methods:** The present study is the further observation of the earlier study reported by Kaur and Koley in 2020, considering small sample size (n=50). The present study deals with the purposively selected 100 patients with plantar fasciitis aged 25 - 45 years from different hospitals of Mohali and Chandigarh, India. The subjects were randomly allocated into two groups, calf stretching (CF) and Achilles tendon stretching (ATS) for 4 - week interventions. To evaluate the pain and foot function disability of the patients, visual analogue scale (VAS) and foot function index (FFI) were assessed from all the subjects in pre - and post - intervention stages. **Results:** The results indicated significant reduction ($p<0.001$) in VAS and FFI in patients with PF after 4 - week interventions using both CF and ATS. The patients treated with ATS had more significant ($p<0.001$) reduction both in VSA and FFI than the patients treated with CF. **Conclusion:** In conclusion it could be stated that patients who reported significant relief from symptoms at the end of 4 - week interventions with ATS were double that of the CF. This findings fall in the same directions of its earlier study.*

Keywords: patients with plantar fasciitis; calf stretching; Achilles tendon stretching

1. Introduction

Plantar fasciitis (PF) is a common foot complication with more than 80% of the cases resolving within 12 months, regardless of therapy (Gill, 1997). It is the most common among individuals aged 40 - 60 years (Buchbinder, 2004). In PF, the fascia undergoes degeneration and becomes tight, thereby leading to hypermobility within the ankle - foot complex, especially talocrural, subtalar and 1st tarsometatarsal joints. Limitation of talocrural joint dorsiflexion would require compensatory movements at more distal joints to allow forward progression of leg over the foot during stance phase of the gait (Prakash and Misra, 2004). Reduction in strength in some muscles of foot and ankle and abnormal foot alignment may lead to develop chronic degenerative changes in long - term PF (Thompson et al., 2014). In fact, among several factors, biomechanical abnormalities are considered as important factors for the causes of PF (Bolivar et al., 2013; League, 2008; Sullivan et al., 2015).

So far treatment of PF is concerned, both operative and non - operative interventions are in use. However, initially, non - operative interventions are advocated as approximately 90% of patients responded positively to these (Neufeld and Cerrato, 2008). Of these non - operative interventions, stretching, mobilization and manipulation, posterior night splints, iontophoresis, foot orthos are in practice. Plantar fascia and Achilles tendon are anatomically connected and stretching of Achilles tendon was considered to be effective

to PF fasciitis (Phoomchai et al., 2018). Effectiveness of calf muscle stretching for short - term treatment in PF was also reported (Radford et al., 2007). Thus in the present study, an attempt has been made to compare the efficacy of CS and ATS for the reduction of pain and foot function disability in patients with PF.

2. Materials and Methods

2.1 Materials

The present study comprised of purposively selected 100 confirmed cases of PF (65 females and 35 males) aged 25 - 45 years from different hospitals of Mohali and Chandigarh, India. The subjects were then randomly allocated into two groups, Group - A consisted of 50 patients those who went under the intervention of CF for 4 weeks for 30 - 40 seconds hold for 3 repetitions per day and Group - B consisted of 50 patients those who went under the intervention of ATS for 4 weeks for 30 - 40 seconds hold for 3 repetitions per day. The Age of the subjects was estimated from their date of birth. A written consent was obtained from all the subjects.

2.2 Methods

Anthropometric Variables

Three anthropometric variables, i. e. height, weight and BMI were measured from all the subjects using the standard techniques prescribed by Lohman et al. (1988) and were measured in triplicate with the median value used as the

criterion. Stadiometer (Holtain Ltd. Crymych, Dyfed, UK) was used for measuring standing height. The weight of the subjects was measured by weighing machine (Model DS - 410, Seiko, Tokyo, Japan) to the nearest 0.1 kg with minimum clothing and bare foot of the subjects. Body mass index (BMI) was calculated from height and weight as follows: $BMI = \text{weight (kg)} / \text{height}^2 (\text{m}^2)$.

Measurement of Visual Analogue Scale (VAS)

The Visual Analogue Scale (VAS) was used to measure the pain of 24 hours as instructed by Bijur et al. (2001). It is a validated method used widely for pain measurement.

Measurement of Foot Function Index (FFI)

A modified Foot Function Questionnaire (Venditto et al., 2015) was used for the study. The questionnaire was designed to give information as to how the foot pain affected the patients' ability to manage in everyday life.

Statistical Analysis

Data was analyzed using SPSS (Statistical Package for Social Science) version 20.0. Independent t - test was applied for all the variables between the patients with plantar fasciitis treated in Group - A and Group - B and between pre - and post - intervention within each group paired - t test was applied. A 5% level of probability was used to indicate statistical significance.

Ethical considerations:

The study was approved by the Institutional Ethical Committee (IEC).

3. Results

The comparison of four anthropometric variables (i. e. age, height, weight and BMI) between PF patients treated with CS and ATS was given in Table 1. The patients treated with CS had higher mean values in age (36.59 years), weight (75.07 kg) and BMI (26.28 kg/m²), and lesser mean value in height (169.14 cm) than their patient counterparts treated with ATS (34.17 years, 74.41 kg, 25.14 kg/m² and 172.07 cm respectively). However, no significant difference was noted in any case.

The comparison of VAS and FFI in pre - and post - intervention PF patients treated with CF was shown in Table 2. The post - intervention patients treated with CF had lesser mean values in VAS (4.27) and FFI (64.01) than their pre - intervention patient counterparts (6.52 and 86.93 respectively). However statistically significant reduction ($p < 0.001$) were noted in VAS ($t = 3.801$, % decrement = 34.51%) and FFI ($t = 3.628$, % decrement = 26.37%) between them.

Table 1: Comparison of anthropometric variables between PF patients treated with CS and ATS

| Variables | Patients treated with CS (n=50) | | Patients treated with ATS (n=50) | | t - value | p - value |
|--------------------------|---------------------------------|--------|----------------------------------|--------|-----------|-----------|
| | Mean | SD (±) | Mean | SD (±) | | |
| Age (years) | 36.59 | 6.09 | 34.17 | 5.38 | 1.032 | 0.250 |
| Height (cm) | 169.14 | 9.63 | 172.07 | 9.44 | 0.865 | 0.269 |
| Weight (kg) | 75.07 | 13.33 | 74.41 | 13.13 | 0.402 | 0.631 |
| BMI (kg/m ²) | 26.28 | 2.76 | 25.14 | 2.39 | 1.432 | 0.081 |

PF = Plantar fasciitis, CS = calf stretching; ATS = Achilles Tendon Stretching

Table 2: Comparison of VAS and FFI between pre - and post - intervention PF patients treated with CS

| Variables | Pre - intervention with CF (n=50) | | Post - intervention with CF (n=50) | | t - value | p - value | % decrement |
|-----------|-----------------------------------|--------|------------------------------------|--------|-----------|-----------|-------------|
| | Mean | SD (±) | Mean | SD (±) | | | |
| VAS | 6.52 | 1.39 | 4.27 | 1.36 | 3.801 | <0.001 | 34.51% |
| FFI | 86.93 | 19.15 | 64.01 | 20.52 | 3.628 | <0.001 | 26.37% |

VAS = Visual Analogue Scale, FFI = Foot Function Index

Table 3 showed the comparison of VAS and FFI in pre - and post - intervention PF patients treated with ATS. The post - intervention patients treated with ATS had lesser mean values in VAS (2.87) and FFI (31.06) than their pre - intervention patient counterparts (6.61 and 77.07

respectively). However statistically significant decrement ($p < 0.001$) were found in VAS ($t = 9.432$, % decrement = 56.58%) and FFI ($t = 8.790$, % decrement = 59.70%) between them.

Table 3: Comparison of VAS and FFI between pre - and post - intervention PF patients treated with ATS

| Variables | Pre - intervention with ATS (n=50) | | Post - intervention with ATS (n=50) | | t - value | p - value | % decrement |
|-----------|------------------------------------|--------|-------------------------------------|--------|-----------|-----------|-------------|
| | Mean | SD (±) | Mean | SD (±) | | | |
| VAS | 6.61 | 1.09 | 2.87 | 1.16 | 9.432 | <0.001 | 56.58% |
| FFI | 77.07 | 14.85 | 31.06 | 15.25 | 8.790 | <0.001 | 59.70% |

The comparison of VAS and FFI in post - intervention PF patients treated with CF and ATS were given in Table 4. The post - intervention patients treated with ATS had lesser mean values both in VAS (2.87) and FFI (31.06) than their

post - intervention patient counterparts treated with CF (4.27 and 64.01 respectively). Statistically significant decrement ($p < 0.001$) were found both in VAS ($t = 3.349$) and FFI ($t = 5.832$) between them.

Table 4: Comparison of VAS and FFI between post - intervention PF patients with CS and ATS

| Variables | Patients treated with CS (n=50) | | Patients treated with ATS (n=50) | | t - value | p - value |
|-----------|---------------------------------|--------------|----------------------------------|--------------|-----------|-----------|
| | Mean | SD (\pm) | Mean | SD (\pm) | | |
| VAS | 4.27 | 1.36 | 2.87 | 1.16 | 3.349 | <0.001 |
| FFI | 64.01 | 20.52 | 31.06 | 15.25 | 5.832 | <0.001 |

4. Discussion

PF is a disorder of the connective tissue which supports the arch of the foot. It causes pain in the heel and bottom of the foot that is usually most severe with the first steps of the day or following a period of rest (Cole et al., 2005). The efficacy of CF and ATS in reducing pain and improving foot function disability in patients with PF was earlier reported by Kaur and Koley in 2020 considering small sample size. In the present study, considerably larger samples were taken to compare the efficacy of CF and ATS for the reduction of pain and to improve the foot function disability in patients with PF. The findings of the present study strongly confirmed the findings of the earlier study conducted by Kaur and Koley (2020), reporting that post - treatment patients treated with both CF and ATS were significantly reduced in VAS ($p < 0.001$) and FFI ($p < 0.001$) than their pre - treatment patients counterparts. But the patients treated with ATS had more significant ($p < 0.001$) reduction both in VAS and FFI than the patients treated with CF. Patients who reported significant relief from symptoms at the end of 4 - week interventions with ATS (%decrements of VAS and FFI 51.27% and 57.00% respectively) were double that of the CF (26.11% and 24.78% respectively).

In fact, for PF, a tight calf muscle and Achilles tendon are the main contributors (Digiovanni, 2006). The findings of the present study also showed that stretching of the calf muscles and Achilles tendon was beneficial for reducing pain and dysfunction associated with this condition. However, Radford et al. (2007) studied the effectiveness of calf muscle stretching for 2 - week stretching program of plantar fasciitis and reported that, in first step pain or foot health, statistically no significant difference was found as compared to their control counterparts. In contrary, in the present study, the interventions with calf stretching were of 4 weeks and significant improvement was recorded. Muir et al. (1999) studied the effect of a static calf stretching exercise on the resistive torque during passive ankle dorsiflexion in healthy subjects and stated that though static stretching of calf had increased ankle dorsiflexion ROM but it did not produce any significant reduction in the passive mechanical resistance in to ankle dorsiflexion. Nonetheless, the findings of the present study also contradicted with the findings of Muir et al. (1999).

Mohamed (2015) reported significant reduction in global measures of pain and disability for patients with chronic plantar fasciitis with the interventions of Achilles tendon stretching. The identical type of findings was available from earlier studies (Digiovanni et al, 2003; Phoomchai et al., 2018, Cole et al., 2005). The findings of the present study fall in the same direction with that of earlier above mentioned studies. In fact, the Achilles tendon and plantar fascia is anatomically connected. The possible reasons for the greater pain - relieving effect of the ATS intervention could be that higher tension was generated within the

Achilles tendon. With greater tension greater flexibility and range of motion were expected. As it has been found that the tissue being stretched developed greater stretch tolerance (Knudson, 2006). This might then allow the tissue to move with less pain. This hypoalgestic effect of the stretching therefore helped to decrease the pain and increase the foot and ankle disability conditions of patients with plantar fasciitis (Phoomchai et al., 2017).

5. Conclusion

From the findings of the present study, it could be concluded that 4 - week interventions with both CF and ATS were significantly effective to reduce the VAS and FFI in patients with plantar fasciitis, the patients treated with ATS had more significant reduction of the outcome variables and the percent decrement of pain and foot function disability were double that of the CF.

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Authors' contributions

All the authors contributed to the conception and design of the study. SSG supervised the study. SK collected and analyzed the data and MKY drafted the manuscript. All the authors contributed to the interpretation of the results.

Competing interests

The authors declare that they have no competing interests.

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