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REVIEW ARTICLE

Isolated Gastrocnemius Contraction and Gastroc Recession Surgery in Case of Planter Fasciitis: A Systemic Review and Meta-Analysis

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Abstract

Objective The current systematic and meta-static review aimed to analyze the correlation between isolated gastrocnemius contracture and plantar fasciitis and the effectiveness of gastroc recession surgery in the treatment of plantar fasciitis.

Methodology The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed to conduct this meta-analysis. A literature search was carried out on the following databases, including Google Scholar, PubMed, EMBASE, and the Cochrane databases with the appropriate medical subject headings (MeSH) to identify the eligible articles.

Results A total of 13 studies were included in this meta-analysis. In this study, there is a significant difference in chronic plantar fasciitis outcome when comparing experimental and control (RR: 0.02; 95% CI: 0.01 to 0.05; $P < 0.001$; $I^2 = 29\%$). There is a significant difference in pain scale outcome when comparing pre-treatment and post-treatment (RR: 3.25; 95% CI 1.44 to 7.32; $P = 0.004 < 0.01$; $I^2 = 0\%$). A significant difference in VAS scale outcome when comparing pre-treatment and post-treatment (RR: 2.58; 95% CI 1.52 to 4.38; $P = 0.0004 < 0.01$; $I^2 = 0\%$).

Conclusion In conclusion, the current systematic review and meta-analysis of gastrocnemius recession and proximal medial gastrocnemius release and other treatment measures for plantar fasciitis suggests that the improvement of ankle dorsiflexion, reduction in pain, and patient satisfaction are almost similar in all the treatment measures. Among the five treatment measures, gastrocnemius recession remains the best, followed by proximal medial gastrocnemius release.

Keywords Gastrocnemius recession · Planter fasciitis · Meta-analysis · Surgery · VAS scale

Introduction

The root of the plantar fascia, located at the medial calcaneal tuberosity of the heel, as well as the surrounding perifascial components, become inflamed due to degenerative processes, which is called plantar fasciitis. The plantar fascia is divided into three segments, all of which originate from the calcaneus and play a significant part in the normal biomechanics of the foot. This ailment is characterized by a lack of inflammatory cells [1]. Heel discomfort that manifests in an outpatient situation is most frequently due to plantar fasciitis. Although estimates suggest that about 1 million clinic visits per year are brought on by plantar fasciitis, the precise estimated prevalence of the condition by age is unknown. About 10% of injuries suffered by runners are caused by this condition, and 11% to 15% of all foot complaints necessitating medical attention are caused by plantar fasciitis. It is estimated that 10% of the overall population also has it, and 83% of patients with it are working, active individuals between the ages of 25 and 65 years. In one-third of cases, it may manifest bilaterally. According to certain studies, the reported prevalence across a cohort of runners is around 22% [2, 3]. Even when treated properly, plantar fasciitis in athletes is associated with substantial morbidity. Plantar fasciitis is deleterious, because it causes foot pain, ambulation problems, exercise restrictions, and the inability to support one's weight.

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The general complications of plantar fasciitis include tendon rupture, necrosis of the fat pad, and arch flattening, which in turn increases the strain. Approximately 5% to 10% of cases were reported for surgical treatments, whereas 75% of cases could be managed without surgical treatments within a year [4]. The clinical manifestations of plantar fasciitis include tightness of Achilles tendon in 80% of cases and medial heel pain [5]. An isolated gastrocnemius contraction is one of the clinical manifestations in patients with foot and ankle pathology [6]. Around 10° of ankle dorsiflexion and full knee extension are required during mid-stance of walking, while the isolated gastrocnemius contracture is a clinical condition which restricts ankle dorsiflexion and may cause problems [7]. Ankle dorsiflexion has been found to be a proven clinical feature of plantar fasciitis [8]. Isolated gastrocnemius tightness has been found to be positively associated with the progression of plantar fasciitis and other foot-related pathological conditions [9]. Rest, muscle-strengthening protocols, non-steroidal anti-inflammatory stimulants, massage, heel pads, steroid, and platelet-rich plasma injections are just a few of the treatments that have been recommended for the management of plantar fasciitis [10, 11]. Around 10% of the patients with plantar fasciitis were reported to show no response to the conservative treatments.

Plantar fasciitis may be efficiently treated using the gastroc recession surgical procedure. Studies have reported that gastroc recession surgery is effective in reducing the pain of patients as well as improving their foot strength and ability to walk [12].The gastroc recession surgery has its own advantages, like minimal complications and a faster recovery period when compared to the other surgical procedures [13]. The most commonly used assessment measures in plantar fasciitis patients are pain by visual analog scale, American Orthopaedic Foot and Ankle–Hindfoot Scale, and ankle dorsiflexion, which is also focused in the current study. Based on the available literature, the current study has been aimed at providing systematic and meta-analysis data on isolated gastrocnemius contracture and gastroc recession surgery in the case of plantar fasciitis patients. This systematic and meta-static review analyze the correlation between isolated gastrocnemius contracture and plantar fasciitis and the effectiveness of gastroc recession surgery in the treatment of plantar fasciitis.

Methodology

Study Design

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were used to conduct this systematic review meta-analysis [14].

Search Strategy

A literature search was carried out on the following databases, including Google Scholar, EMBASE, PubMed, and the Cochrane databases with the appropriate medical subject headings (MeSH) to identify the eligible articles. Different combinations of keywords were used for the search strategies such as plantar fasciitis, plantar fasciopathy, heel spur syndrome, and gastrocnemius, with the Boolean operators (and, or). To search other databases, the keywords were changed according to each databases. The bibliographic sources were also screened for the selected articles.

Inclusion and Exclusion Criteria

All the published articles were reports with a description of surgical management of calcaneal fractures published until June 2022, Original research studies with a level of evidence of III or higher (case–control, cohort, randomized-controlled trials) evaluating the results of gastrocnemius recession in human patients with chronic plantar fasciitis were included. Exclusion criteria were: case reports or surgical technique reports, patients treated by a primary arthrodesis, grey literature, including presented abstracts, letters to the editors, commentaries, and systematic review or meta-analysis articles.

Article Screening

An author independently executed articles screening process and eligibility assessment. The articles were initially screened on the basis of its title, followed by abstract of the article. In the case, title and abstract of the articles were irrelevant to the present investigation; these were excluded for the secondary screening. The selected articles from the initial screening were assessed for full-text screening to find out the eligibility criteria of the present study. The full-text assessed articles were further excluded based on insufficient information regarding the management of calcaneus fracture.

Data Extraction

Relevant articles were chosen for full-text screening after application of the eligibility criteria. The name of the authors and year, study type, number of patients, male:female ratio, mean age, follow-up period, objective of the study, complications, clinical condition diagnosed, treatment provided, pre-treatment Observations, post-treatment observations,

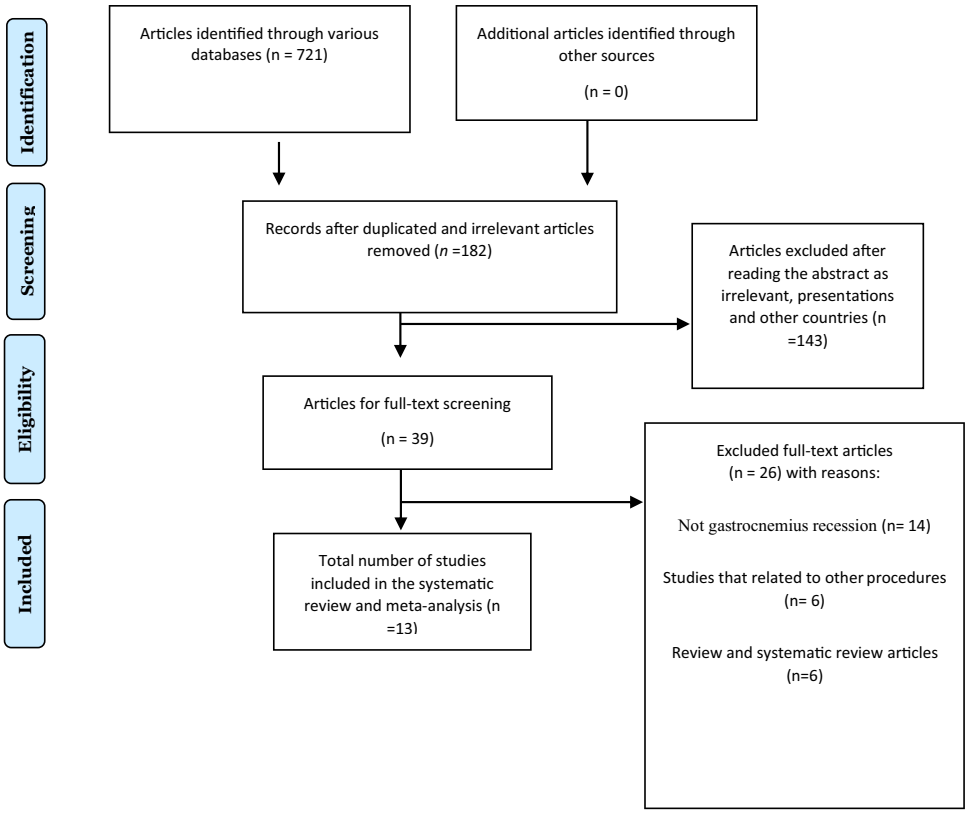


Fig. 1 PRISMA flowchart

and outcome of the study were extracted from the selected article.

Quality Assessment

All included case series and cohort studies were evaluated for quality and bias using the Methodological Index for Non-Randomized Studies (MINORS) criteria. The MINORS criteria comprise a 12-item checklist, each item given a score of 0 (not reported), 1 (inadequately reported), or 2 (adequately reported). For noncomparative research, a maximum of 16 points, and for comparative studies, a maximum of 24 points, were used to assess the studies. Using a critical assessment checklist developed by the Joanna Briggs Institute, the quality of randomized-controlled trials was evaluated. This consists of a 13-item checklist, with each item scored using either "yes," "no," or "not reported."

Statistical Analysis

Statistical analyses were performed using the Cochrane Collaboration Review Manager 5.4 (Cochrane Collaboration, version 5.4, London, UK). Data were pooled if an outcome was reported in at least three studies and if heterogeneity between studies was absent or low. Heterogeneity was assessed using the I^2 index. Risk ratios including 95% confidence intervals (CI) were calculated in the case of dichotomous outcome measures including 95% confidence intervals (CI) were used. For each meta-analysis, the random-effects model was used. A P value less than 0.05 was considered statistically significant (two-sided test).

Results

Eligible Studies

The literature search yielded 721 articles from various databases Google Scholar, EMBASE, PubMed, MEDLINE, and the Cochrane databases, of which 539 articles were excluded at the initial stage due to repetition and irrelevance. After examination of the titles and abstracts at the initial screening stage, 143 articles out of 182 were further excluded. A total of 39 potentially relevant articles were selected for full-text evaluations, of which 26 articles were further excluded as the not gastrocnemius recession ($n = 14$), studies that related to other procedures ($n = 6$), and review and systematic review articles ($n = 6$). Finally, 13 studies meeting the inclusion criteria of the current systematic review as detailed in the PRISMA flowchart (Fig. 1) were included in this research.

Table 1 Baseline characteristics of the included studies

S.no	Author and year	Study type	Number of patients	Male: female ratio	Mean age	Follow-up period	Objective of the study	Complications	Clinical condition diagnosed	Treatment provided	Pre-treatment observations	Post treatment observations	Outcome of the study
1	Chimera et al. [21]	Clinical study	4	3:1	50.6 years	3 months	To assess range of motion, function, and plantarflexion strength pre- and 3-months post-gastrocnemius recession for subjects with isolated gastrocnemius contracture	No major complications observed	Isolated gastrocnemius contracture	Gastrocnemius recession	Passive ankle dorsiflexion range of motion: 59 (10)*; global rating: 48 (20) *	Passive ankle dorsiflexion range of motion: 91 (6)!; global rating: 86 (11)!	Post-surgically isolated gastrocnemius contracture subjects were more similar to healthy controls
2	Patel and DiGiovanni [8]	Prospective study	254	Not evident	49 years	9 months	To determine the proportion of patients with plantar fasciitis that have an associated isolated gastrocnemius contracture	persistent pain, the development of complex regional pain syndrome, medial arch collapse as well as the development of a painful plantar incision	Acute and chronic plantar fasciitis	Gastrocnemius recession	Pain scale score: 8/10	Pain scale: 2/10	Limited ankle dorsiflexion is commonly associated with plantar fasciitis and more than half of these patients had evidence of an isolated gastrocnemius contracture

Table 1 (continued)

S.no	Author and year	Study type	Number of patients	Male: female ratio	Mean age	Follow-up period	Objective of the study	Complications	Clinical condition diagnosed	Treatment provided	Pre-treatment observations	Post treatment observations	Outcome of the study
3	Abbassian, Ali et al. [25]	Retrospective case series	17 (21 feet)	3:14	52 years	3 years	To observe the proximal medial gastrocnemius release in the treatment of recalcitrant plantar fasciitis	No major complications observed	Plantar fasciitis	Proximal medial gastrocnemius release	Not reported	Made worse: 0 No Change: 2 Some improvement: 2 Significant improvement: 8 pain free: 9	Proximal medial gastrocnemius release efficiently treats plantar fasciitis
4	Manuel Monteagudo et al. [15]	Retrospective study	60	34:26	42 years	1 year	To compare results of partial proximal fasciotomy with proximal medial gastrocnemius release	Calf hematoma (but no treatment was needed)	Chronic plantar fasciitis	Plantar fasciotomy and Proximal Medial Gastrocnemius Release	Plantar fasciotomy—visual analog score: 8.1; American orthopaedic foot and ankle-hindfoot Scale: 48 Proximal medial gastrocnemius release—visual analog score: 8.2; American orthopaedic foot and ankle-hindfoot Scale: 46	Plantar fasciotomy—visual analog score: 4.5 to 3.1; American orthopaedic foot and ankle-hindfoot scale: 55 to 66 Proximal Medial gastrocnemius release—visual analog score: 1.8 to 0.9; American orthopaedic foot and ankle-hindfoot scale: 85 to 90	95% satisfaction rate in proximal medial gastrocnemius release; 60% satisfaction in plantar fasciotomy

Table 1 (continued)

S.no	Author and year	Study type	Number of patients	Male: female ratio	Mean age	Follow-up period	Objective of the study	Complications	Clinical condition diagnosed	Treatment provided	Pre-treatment observations	Post treatment observations	Outcome of the study
.5	Villanueva et al. [20]	Clinical study	23	18:05	49 years	Up to 1 year	To evaluate the safety and efficacy of a new technique based on ultrasound-guided ultra–minimally invasive gastrocnemius recession	No major complications observed	Chronic non-insertional Achilles tendinopathy, equinus foot	Gastrocnemius recession	Ankle dorsiflexion < 10°; Visual analog score: 7; american orthopaedic foot and ankle-hindfoot Scale: 30	Ankle dorsiflexion 14°; Visual analog score: 2.8 to 1; American orthopaedic foot and ankle-hindfoot scale: 68.76 to 93	The technique is effective
6	Nicholas Cheney et al. [16]	Retrospective study	68	Not provided	Not provided	8 weeks	To perform an isolated gastrocnemius recession for the treatment of plantar fasciitis	Not reported	Gastrocnemius equinus contracture and plantar fasciitis	Gastrocnemius recession	Pain scale score: 7.4/10	Pain scale score: 2.8/10 to 3.3/10	Isolated gastrocnemius recession can decrease the pain score in patients with recalcitrant plantar fasciitis
7	Ficke et al. [12]	Retrospective study	17	5:12	46 years	20 months	To evaluate the efficiency of gastrocnemius recession in chronic plantar fasciitis treatment	Minor—sural neuritis, foot drop, calcaneal stress fracture, subjective calf weakness, no wound or infections	Chronic plantar fasciitis	Gastrocnemius recession	Pain scale score: 8.3/10	Pain scale score: 2.4/10	Gastrocnemius recession improved foot function and pain symptoms in chronic plantar fasciitis patients

Table 1 (continued)

S.no	Author and year	Study type	Number of patients	Male: female ratio	Mean age	Follow-up period	Objective of the study	Complications	Clinical condition diagnosed	Treatment provided	Pre-treatment observations	Post treatment observations	Outcome of the study
8	Molund et al. [23]	Randomized control study	40	9:31	45 years	1 year	To evaluate the clinical and biomechanical outcomes of gastrocnemius recession and stretching compared with a stretching exercise protocol for patients with plantar heel pain lasting more than 12 months	Minor complications prolonged swelling or pain	Plantar heel pain	Proximal medial gastrocnemius release	American orthopaedic foot and ankle-hindfoot scale: 59.5; ankle dorsiflexion: 6°; foot plantar pressure: 536 kpa; visual analog score: 7.6; short form-36 score: 65	American orthopaedic foot and ankle-hindfoot scale: 88; ankle dorsiflexion: 10.5°; foot plantar pressure: 642 kpa; visual analog score: 3.3 to 2.8; short form-36 score: 90	Proximal medial gastrocnemius recession with a stretching program was a safe and efficient method of treating chronic plantar heel pain

Table 1 (continued)

S.no	Author and year	Study type	Number of patients	Male: female ratio	Mean age	Follow-up period	Objective of the study	Complications	Clinical condition diagnosed	Treatment provided	Pre-treatment observations	Post treatment observations	Outcome of the study
9	Mulhern et al. [24]	Retrospective case series	23	4:19	51.2 ± 12.5 years	3.7 months	To determine the effectiveness of combined gastrocnemius recession and endoscopic plantar fasciotomy to improve pain and range of motion	No major complications observed. Minor—nerve injury, formation of scar tissue adhesions, hematomas, recalcitrant plantar fasciitis, posterior stiffness posterior muscle weakness, and an infected incision	Plantar fasciitis	Gastrocnemius recession and endoscopic plantar fasciotomy	Pain scale score: 5.9 ± 2.1; Ankle dorsiflexion: -0.8 ± 6.5°; Plantar flexion: 40.3 ± 10.6°; Inversion: 28.9 ± 11.5°; Eversion: 9.2 ± 4.5°	Pain scale score: 1.5 ± 1.7; Ankle dorsiflexion: 8.8 ± 5.6°; Plantar flexion: 41.1 ± 9.4°; Inversion: 30.8 ± 10.5°; Eversion: 12.8 ± 5.2°	Combined gastrocnemius recession and endoscopic plantar fasciotomy improves pain and range of motion

Table 1 (continued)

S.no	Author and year	Study type	Number of patients	Male: female ratio	Mean age	Follow-up period	Objective of the study	Complications	Clinical condition diagnosed	Treatment provided	Pre-treatment observations	Post treatment observations	Outcome of the study
10	Gamba et al. [22]	Randomized controlled trial	36	11:25	46.2 years	1 year	To compare the results obtained from proximal medial gastrocnemius release with those obtained from open plantar fasciotomy	Uneventful healing of wound; superficial wound infection; sural nerve lesion	Recalcitrant plantar fasciitis	Open plantar fasciotomy (OPF) and Proximal Medial Gastrocnemius Release (PMGR)	OPF—American orthopaedic foot and ankle-hindfoot scale: 68.7 ± 8.2; visual analog score: 69.5 ± 18	OPF—American orthopaedic foot and ankle-hindfoot scale: 78.7 ± 10.5 to 86.7 ± 12.1; Visual analog score: 40.4 ± 22.2 to 28.7 ± 25.6	No significant variation between groups observed
											PMGR—American Orthopaedic Foot and Ankle-Hindfoot Scale: 65.3 ± 10.4; Visual analog score: 68.1 ± 18.8	PMGR—American Orthopaedic Foot and Ankle-Hindfoot Scale: 87.1 ± 8.1 to 89 ± 9.9; Visual analog score: 36.3 ± 21.3 to 15.1 ± 18.3	
11	Christopher J. Pearce [18]	Prospective study	33	21:12	44 years	9 months	To determine the correlation between gastrocnemius tightness and the severity of heel pain in plantar fasciitis	No major complications reported	Plantar fasciitis	Alfredson's eccentric stretching regime	Visual analog score: 7.6	Visual analog score: 2.5	Gastrocnemius tightness and the severity of heel pain in plantar fasciitis are significantly related

Table 1 (continued)

S.no	Author and year	Study type	Number of patients	Male: female ratio	Mean age	Follow-up period	Objective of the study	Complications	Clinical condition diagnosed	Treatment provided	Pre-treatment observations	Post treatment observations	Outcome of the study
12	Hoefnagels et al. [19]	Level II clinical studies	32	9:23	50 years	1 year	To evaluate the effect of lengthening the gastrocnemius muscle	Minor complaints—one superficial wound infection, neuropraxia of the sural nerve	Plantar fasciitis	Achilles tendon and plantar fascia stretching and Gastrocnemius recession	Visual analog score: 7.8; Ankle dorsiflexion: median -5°	Visual analog score: 2.0; Ankle dorsiflexion: 10°	Gastrocnemius recession results in a significant gain in dorsiflexion
13	Rahul Upadhyay et al. [17]	Prospective study	20	12:08	40.5 years	9 months	Evaluation of functional outcomes in patients treated with gastrocnemius recession for chronic plantar fasciitis due to isolated gastrocnemius tightness	No major complications observed	Plantar fasciitis	Gastrocnemius recession	Visual analog score: 7.2; American-Orthopaedic Foot and Ankle-Hindfoot Scale: 49.4	Visual analog score: 1.2; American-Orthopaedic Foot and Ankle-Hindfoot Scale: 93.3	High satisfaction in 18 patients; Partial satisfaction in 2 patients

Table 2 Risk-of-bias assessment of the included studies

Author[a]	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Gamba et al. [22]	Y	Y	Y	NR	N	N	Y	Y	Y	Y	Y	Y	Y	10/13
Molund et al. [23]	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	11/13

Author[b]	1	2	3	4	5	6	7	8	9	10	11	12	Total
Chimera et al. [21]	2	0	2	2	0	1	2	0	2	0	2	2	15/24
Patel and DiGiovanni [8]	2	1	2	2	0	1	2	0	2	1	2	2	17/24
Abbassian, Ali et al. [25]	2	2	1	1	0	2	2	0	1	2	1	1	15/24
Manuel Monteagudo et al. [15]	2	0	1	2	0	2	2	0	2	2	2	2	17/24
Villanueva et al. [20]	2	1	2	2	0	NA	2	0	2	1	2	2	16/22
Nicholas Cheney et al. [16]	1	1	2	2	0	1	2	0	2	2	1	2	16/24
Ficke et al. [12]	2	0	2	2	1	2	2	0	2	1	2	2	18/24
Mulhern et al. [24]	1	1	2	2	0	2	1	0	2	2	2	2	17/24
Christopher J. Pearce [18]	2	2	2	1	0	2	2	0	2	2	2	2	19/24
Hoefnagels et al. [19]	2	1	2	2	0	2	2	0	NA	NA	NA	NA	11/16
Rahul Upadhyay et al. [17]	2	0	1	2	0	2	2	0	2	1	1	2	15/24

[a]Risk-of-bias and quality of evidence assessment of included randomized-controlled trials using the Joanna Briggs Institute critical appraisal checklist. Numbers 1–13 in the first row, refer to the equivalent items in the Joanna Briggs Institute checklist

[b]Risk-of-bias and quality of evidence assessment of included case series and cohort studies using the Methodological Index for Non-Randomized Studies (MINORS) criteria. Numbers 1–12 in the first row, refer to the equivalent items in the MINORS checklist

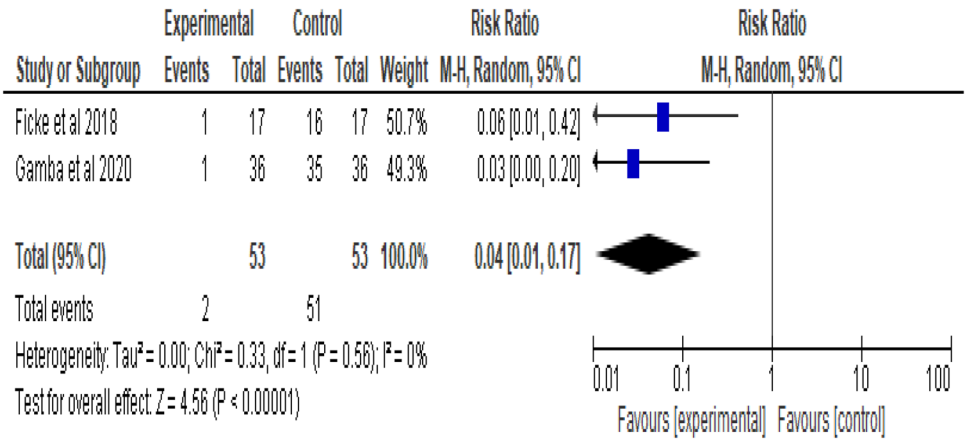


Fig. 2 Forest plot showing the risk ratio for sural nerve lesion complication

Baseline Characteristics

Among the included 13 studies, 3 studies were retrospective [12, 15, 16], 3 studies were prospective study [8, 17, 18], 3 studies were clinical study [19]–[21], 2 studies were randomized-controlled trial [22, 23], and 2 studies were retrospective case series [24, 25]. A total of 627 patients were included in the current systematic review, with sample sizes ranging from 4 to 254 patients, of which the majority of the patients were female. The mean age of the patients was ranging from 40.5 to 52 years and the follow-up duration were ranging from 8 weeks to 3 years (Table 1). The risk-of-bias assessment of the included studies was provided in Table 2.

Complications

Meta-analysis showed in two studies that there is a significant difference in sural nerve lesion outcome when comparing experimental and control (RR: 0.04; 95% CI 0.01 to 0.17; $P < 0.001$; $I^2 = 0\%$) (Figs. 2 and 3).

Superficial Wound

Meta-analysis showed in two studies that there is a significant difference in superficial wound outcome when comparing experimental and control (RR: 0.03; 95% CI 0.01 to 0.12; $P < 0.001$; $I^2 = 0\%$) (Figs. 4 and5).

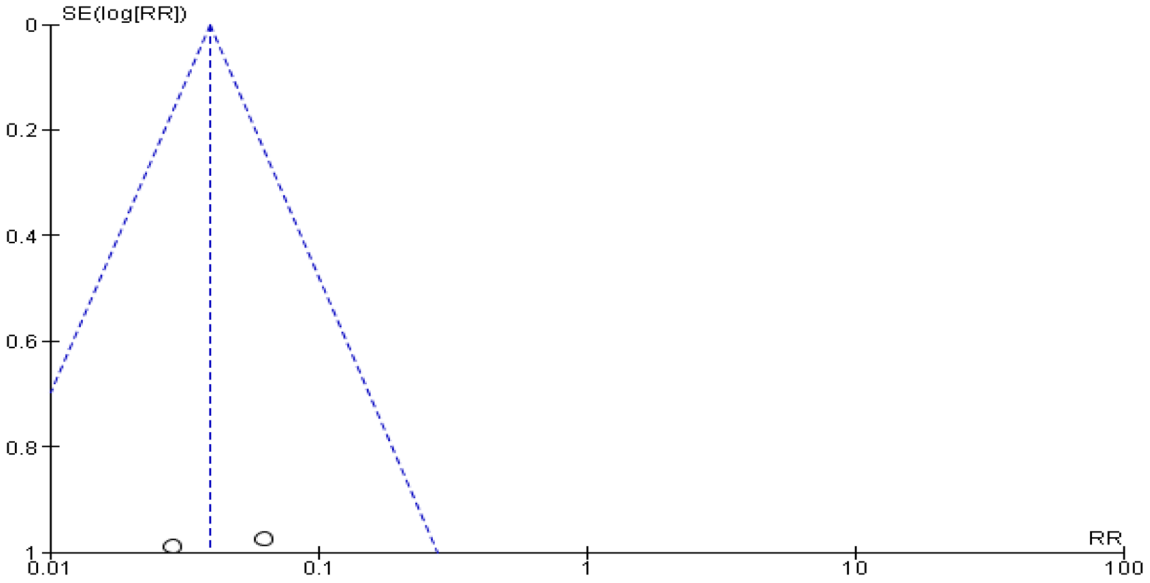
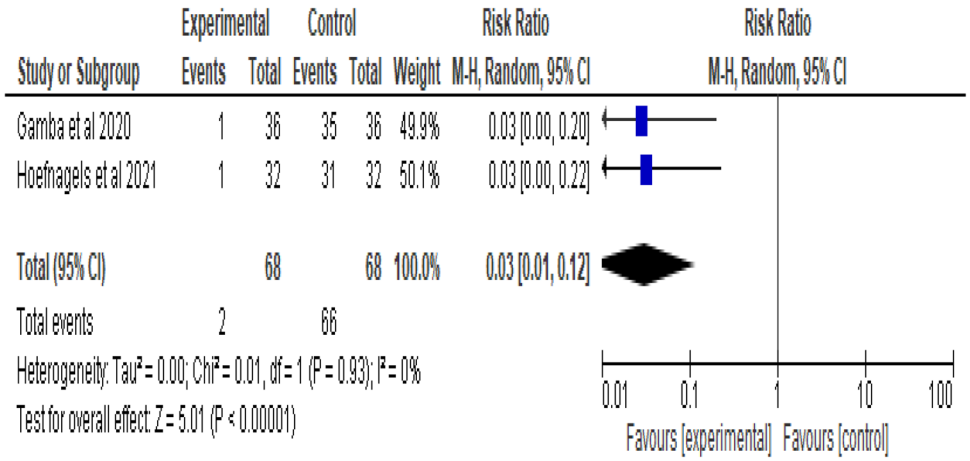


Fig. 3 Funnel plot showing the risk ratio for sural nerve lesion complication

Fig. 4 Forest plot showing the risk ratio for superficial wound complication



Clinical Condition Diagnosed

Chronic Plantar Fasciitis

Results showed in ten studies that there is a significant difference in chronic plantar fasciitis outcome when comparing experimental and control (RR: 0.02; 95% CI 0.01 to 0.05; $P < 0.001$; $I^2 = 29\%$) (Figs. 6 and 7).

Treatment Provided

Pain Scale

Meta-analysis showed in three studies that there is a significant difference in pain scale outcome when comparing pre-treatment and post-treatment (RR: 3.25; 95% CI 1.44 to 7.32; $P = 0.004 < 0.01$; $I^2 = 0\%$) (Figs. 8 and 9).

Visual Analog Scale (VAS)

Results showed in six studies that there is a significant difference in VAS scale outcome when comparing pre-treatment and post-treatment (RR: 2.58; 95% CI 1.52 to 4.38; $P = 0.0004 < 0.01$; $I^2 = 0\%$) (Figs. 9, 10, 11).

Discussion

The current study is a systematic and meta-analysis that has been framed with the objective of analyzing the possible inter-relationship and correlation between isolated

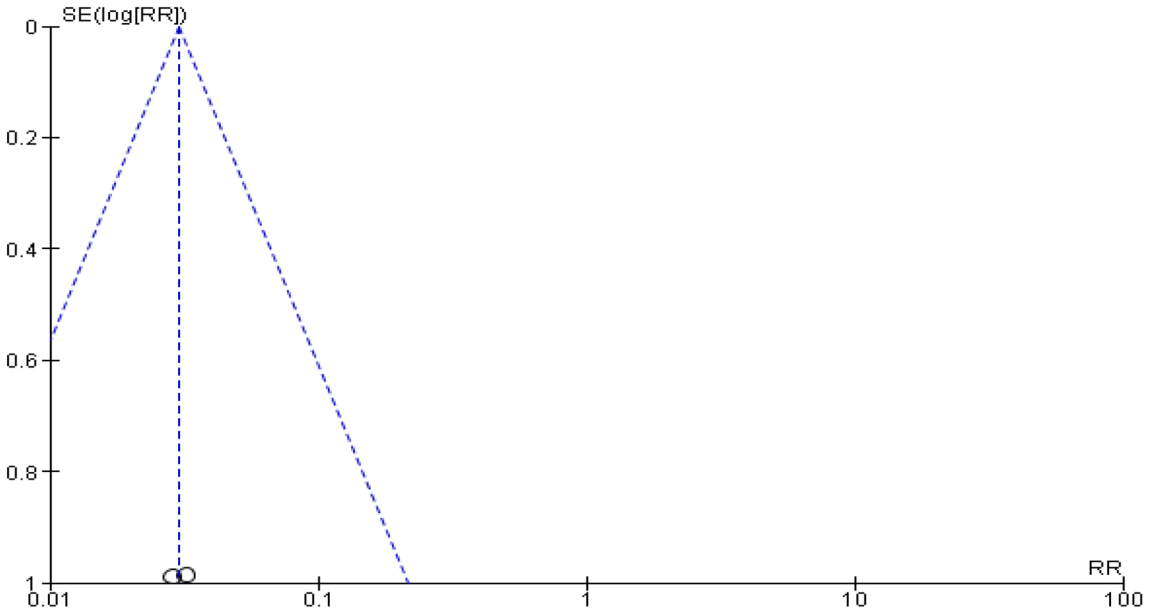
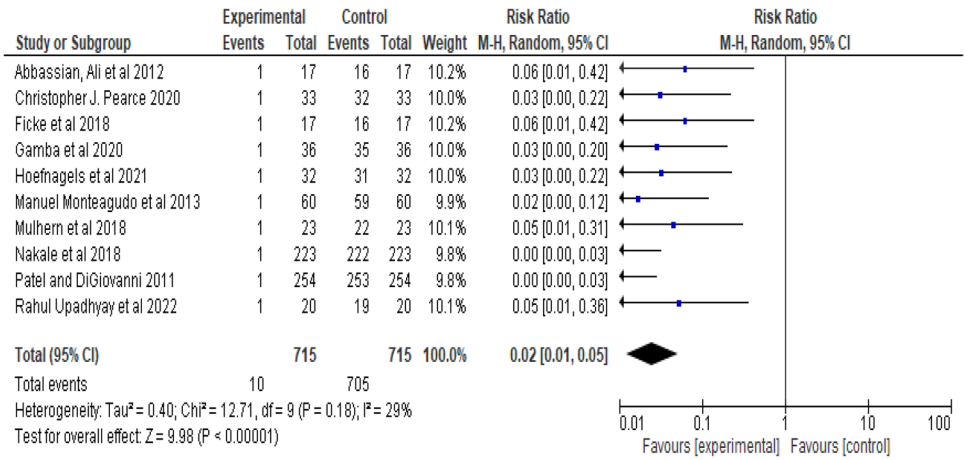


Fig. 5 Funnel plot showing the risk ratio for superficial wound complication

Fig. 6 Forest plot showing the risk ratio for chronic plantar fasciitis



gastrocnemius contracture and plantar fasciitis. The study has also been extended to evaluate the effectiveness of gastroc recession surgery in the treatment of plantar fasciitis. This study included three retrospective analyses, three prospective studies, three clinical studies, two randomized-controlled trials, and two retrospective case series, comprising 13 studies in total.

Among the 13 studies, only two studies had an inconsistent sample size, while the other 11 studies had a sample size ranging from 17 to 68. In 8 of the 13 studies (around 62%) involved gastrocnemius recession as treatment, in which six studies, gastrocnemius recession was the only treatment provided to the patients, and in one study by Mulhern et al. [24], gastrocnemius recession was combined with endoscopic plantar fasciotomy. Another study by Hoefnagels et al. [19] has reported the use of Achilles tendon and plantar fascia stretching along with gastrocnemius recession for the treatment of plantar fasciitis. Around 30% of the analyzed studies (4 out of 13) involved proximal medial gastrocnemius release as the treatment measure. Among the four, a study by Gamba et al. [22] has reported the use of proximal medial gastrocnemius release and open plantar fasciotomy as treatment measures for recalcitrant plantar fasciitis, whereas Manuel Monteagudo et al. [15] have stated plantar fasciotomy as a treatment option along with proximal medial gastrocnemius release. Alfredson's eccentric stretching regime was reported as a treatment measure for plantar fasciitis by Christopher Pearce [18] alone.

Only two studies reported major complications after the treatment of plantar fasciitis, but the treatment measures

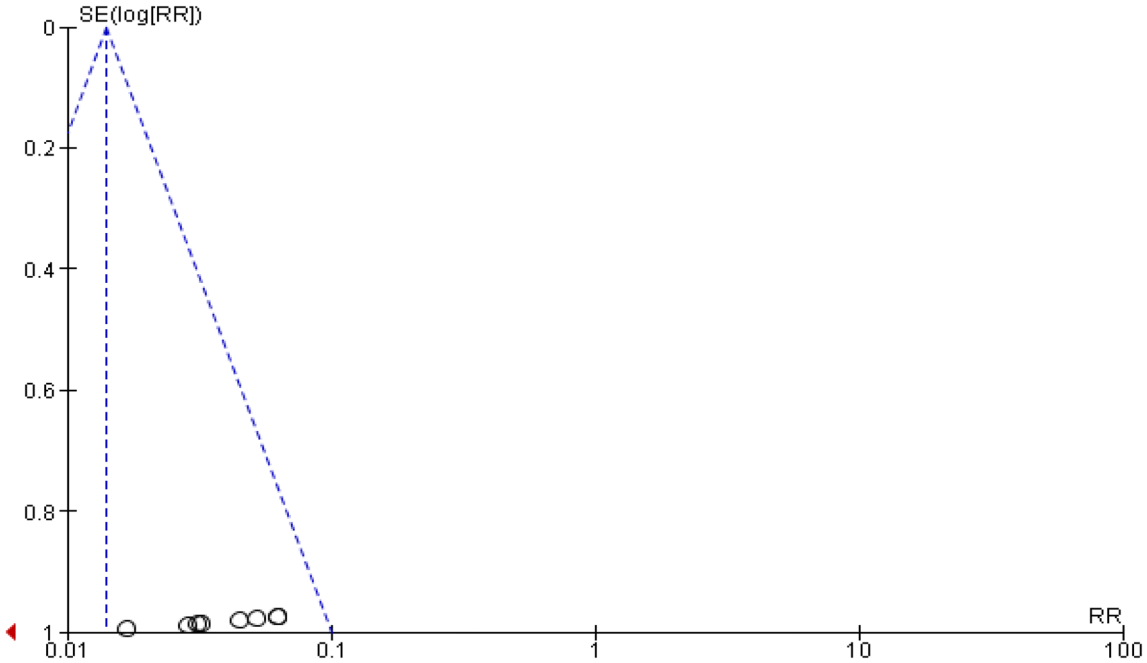
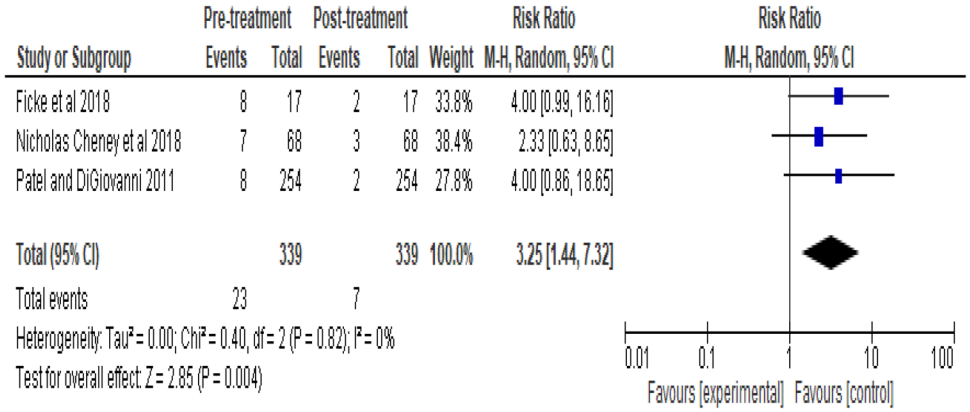


Fig. 7 Funnel plot showing the risk ratio for chronic plantar fasciitis

Fig. 8 Forest plot showing the risk ratio for pain scale



were eventually different. Patel and DiGiovanni et al. [8] observed persistent pain, the development of complex regional pain syndrome, medial arch collapse, and the development of a painful plantar incision as complications for gastrocnemius recession treatment, whereas Gamba et al. [22]observed uneventful wound healing, superficial wound infection, and sural nerve lesions in proximal medial gastrocnemius release and open plantar fasciotomy treatments. There is no significant correlation between the occurrence of major complications. Although the majority of the studies reported no complications, minor complications that required minimal or no treatment were also reported.

A visual analog scale for pain measurement with a score of 0–10 was used anonymously in all the studies using gastrocnemius recession and Alfredson's eccentric stretching regime to measure the pain before and after treatments. The pain reduced significantly after the treatment, irrespective of the method of treatment used. Both the treatment methods had almost similar observations in pain reduction, with a mean of 7.8/10 to 2.0/10. In the case of proximal medial gastrocnemius release, the visual analog score was reported only in a retrospective study conducted by Manuel Monteagudo et al. [15], which showed a higher response rate of 8.2/10 to 1.8/10, whereas plantar fasciotomy was not so efficient in the reduction of pain (8.1/10 to 4.5/10). Ankle dorsiflexion has not been reported to be significantly associated with plantar fasciitis prevalence as per the previous reports [26, 27]. However, our study has revealed that ankle dorsiflexion improved after treatment despite the mode of treatment. All the treatment measures considered in the

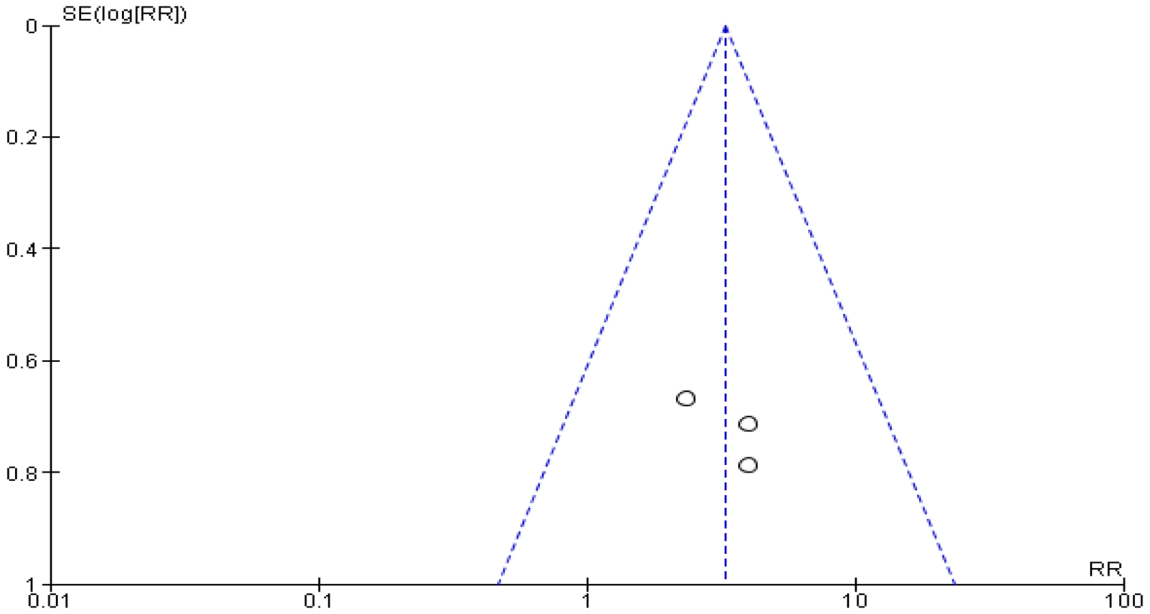
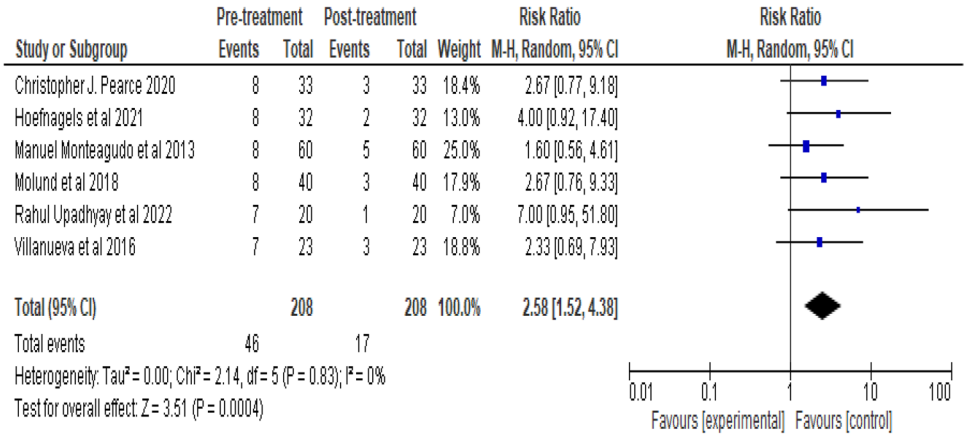


Fig. 9 Funnel plot showing the risk ratio for pain scale

Fig. 10 Forest plot showing the risk ratio for VAS



current systematic analysis revealed similar results, indicating the positive correlation between ankle dorsiflexion and plantar fasciitis. The American Orthopaedic Foot and Ankle-Hindfoot scale measurement was the other measurement evaluated in the current analysis. The observations were all positive in terms of improvement for all treatment measures. However, gastrocnemius recession had higher efficiency scores (mean of 26.2 before treatment to 81.0 after treatment) than the other treatment measures, although proximal medial gastrocnemius release showed considerably better improvement (before treatment: 56.6 to after treatment: 86) than open plantar fasciotomy (before treatment: 68 to after treatment: 78.7) and plantar fasciotomy (before treatment: 48 to after treatment: 55). On considering the treatment outcomes, the patient satisfaction rates were higher in both gastrocnemius recession and proximal medial gastrocnemius release.

There are a few limitations to our study. First, the sample size of the considered studies varied, and second, the follow-up period was different between the studies. The complications of considered treatment measures were not well reported in the current literature, and hence, further studies are needed on that basis to ensure our findings.

Conclusion

The present review of gastrocnemius recession and proximal medial gastrocnemius release and other treatment measures for plantar fasciitis suggests that the improvement of ankle dorsiflexion, reduction in pain, and patient

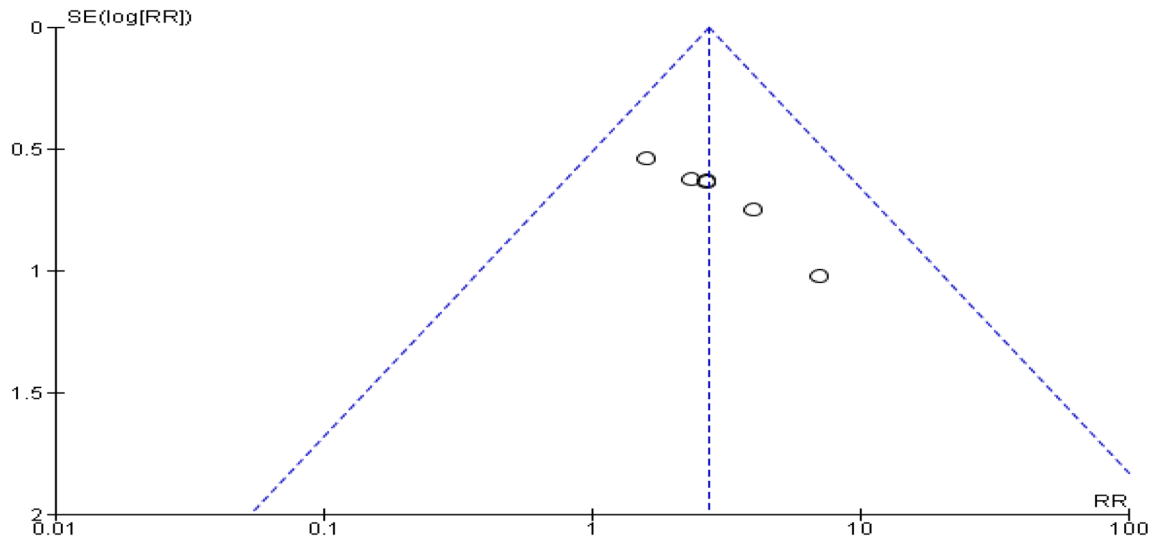


Fig. 11 Funnel plot showing the risk ratio for V

satisfaction are almost similar in all the treatment measures. Among the five treatment measures, gastrocnemius recession remains the best, followed by proximal medial gastrocnemius release.

Data availability The datasets used in the current systematic review was obtained from the previously published articles.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with human or animal subjects performed by the any of the authors.

Informed consent For this type of study informed consent is not required.

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