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Review Article

A Systematic Review of Plantar Plate Repair in the Management of Lesser Metatarsophalangeal Joint Instability

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ABSTRACT

The plantar plate is a major structure that maintains metatarsophalangeal joint (MTPJ) stability and has only recently gained attention. Anatomic plantar plate repair can directly address the pathologic entity, rather than relying on indirect reduction of the MTPJ instability by osteotomy or tendon transfer techniques. The present report aimed to determine the effectiveness of plantar plate repair for the treatment of patients with lesser MTPJ instability. Different databases were searched using the guidelines in the Cochrane Handbook and recommendations from the Preferred Reporting Items for Systematic reviews and Meta-Analysis statement. Six case series, describing 162 patients who had undergone plantar plate repair in conjunction with either Weil osteotomy or flexor digitorum longus transfer, were retrieved. Favorable outcomes were described in each of the studies included in the present systematic review. However, these results should be interpreted with caution because of the methodologic limitations and biases inherent in the included studies. More rigorous clinical investigations are required to fully understand the effectiveness of plantar plate repair for the management of lesser MTPJ instability.

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Metatarsalgia is a common condition used to describe generalized forefoot pain, and metatarsophalangeal joint (MTPJ) instability is one of the most common causes for this condition (1,2). Coughlin (3,4) initially introduced a crossover toe as a term in 1986 to describe the end result of MTPJ instability, with a dorsomedial pattern of subluxation of the second toe. The causes of lesser toe subluxation and dislocation are still unclear but are probably multifactorial. Risk factors such as acute trauma, high-fashion shoe wear, rheumatoid arthritis, and other various inflammatory conditions have all been linked to metatarsalgia and lesser MTPJ instability (3–5).

For more than 25 years, the management of lesser MTPJ instability has been characterized by indirect repairs of the deformity using soft tissue release, extensor or flexor tendon transfer, and periarticular osteotomy (6–9). However, these indirect methods do not directly repair the plantar plate or collateral ligaments. In addition, unsatisfactory clinical results have been reported for tendon transfer procedures, which are controversial owing to the prolonged swelling and stiffness that can result (10). Therefore, as an alternative treatment,

plantar plate repair (PPR), which directly addresses the pathologic features, rather than relying on indirect reduction of the MTPJ with osteotomy or tendon transfer techniques, has been reported (11). PPR acts exclusively on the distal part of the planter plate mechanism by repairing the attenuated or failed distal portion of the plantar plate back onto the base of the proximal phalanx of the toe (12).

Materials and Methods

The study selection criteria (Table 1) for the present review were defined by the population, interventions, comparators, outcomes, and study design of each included study (PICOS [participants, interventions, comparators, outcomes, study design]). The used the following online search engines: Cochrane Database of Systematic Reviews, Cochrane Library, MEDLINE, Database of Abstracts of Reviews of Effectiveness, Web of Sciences, Academic Search Premier, and CINAHL. The terms “lesser metatarsophalangeal joints instability” or “plantar plate tears” and “lesser toe subluxation/dislocation,” “plantar plate repair,” “Weil osteotomy,” “flexor tendon transfer,” and “systematic review” or “review” were used with “plantar plate repair” or “PPR” in turn to retrieve potentially relevant studies contained in these databases. All reported studies from the inception of data until March 2017 that investigated the effectiveness of PPR were included in the present review. The studies obtained from each database were merged to eliminate replicas. After filtering the duplicate studies and studies not fulfilling the inclusion criteria, 11 studies were retrieved. All 11 studies were read in full. Of the 11 studies, 3 were excluded because these studies had investigated surgical techniques only and had not evaluated pain or functional outcomes. Another 2 studies were excluded because the interventions had been performed on cadaver specimens. Finally, 6 studies were included in the present review. Of these, 5 were reported in English and 1 in Chinese (Fig.).

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Table 1
Eligibility criteria

Criterion	Yes	No
Participants	Participants aged ≥ 18 y diagnosed with lesser MTPJ instability and degenerative plantar plate rupture	Participants aged < 18 y diagnosed with lesser MTPJ instability and degenerative plantar plate rupture
Intervention	PPR or combined intervention, with PPR for treatment of lesser MTPJ instability	PPR applied on cadaver to evaluate or compare effectiveness of results
Comparators	Any intervention applied to participants to compare outcomes of PPR	
Outcomes	Clearly defined set of relevant assessments on pain and functional outcomes and possible adverse effects of intervention reported	Studies not reporting outcomes of PPR as treatment applied to patients with lesser MTPJ instability
Study design	All study designs were screened to include any potentially relevant studies on the topic	

Abbreviations: MTPJ, metatarsophalangeal joint; PPR, plantar plate repair.

Results

Bouché and Heit (13) evaluated their case series of PPRs performed using an associated flexor digitorum longus (FDL) transfer. They hypothesized that this would address both the dynamic and the static elements of lesser MTPJ instability (13). They retrospectively reviewed the cases of 18 patients (20 feet) who had undergone this procedure from 1997 to 2003; 15 patients (17 feet) were available for the final analysis. Using both subjective and objective pre- and postoperative measures, they reported a postoperative visual analog scale score of 8 (13), where 0 indicated complete dissatisfaction with the surgery and 10 complete satisfaction. Of the 15 patients, 5 rated their surgery as completely effective, 6 as very effective, and 4 as somewhat effective (13). The average American Orthopaedic Foot and Ankle Society (AOFAS) scale score postoperatively was 83.2; no preoperative AOFAS scale scores were provided (13). Their results should be interpreted with caution owing to a few limitations such as the small patient numbers, retrospective study, and application of invalidated questionnaires (13).

Gregg et al (12) reviewed their case series of patients who had undergone combined PPR and Weil's osteotomy. The rationale behind performing PPR with Weil's osteotomy was to eliminate the problems associated with a floating toe associated with Weil's osteotomy performed in isolation (12). From 2002 to 2004, 35 procedures were performed on 23 feet (21 patients); the data were collected retrospectively. The mean clinical follow-up period was 26 months. Preoperatively, pain was rated as severe in 15 feet, moderate in 6, and mild in 2. Postoperatively, patients self-reported 11 feet as having an excellent result, 10 having a fair result, and 2 a poor result. In terms of satisfaction postoperatively, 17 were satisfied with surgery and 6 were not. In addition, 8 feet experienced no postoperative stiffness, 13 had noticeable stiffness, and 2 had stiffness that impaired patients' activities (12). The mean postoperative AOFAS scale score was 88.9 (range 63 to 100) (12).

Weil et al (14) also applied a similar method to repair the plantar plate. They only evaluated second MTPJ instability and retrospectively analyzed the results in 13 patients (15 feet). They also used a dorsal approach and performed Weil's osteotomy and PPR concurrently. They demonstrated a reduction in the preoperative and postoperative visual analog scale score from 7.3 to 1.7 and a postoperative AOFAS scale score of 85.7 (14). They also reported that the patients who had undergone 12 of 15 procedures would recommend the procedure to treat the same pathologic features; 3 patients were not satisfied with surgery but 1 of these patients would still have recommended the procedure (14). These findings should also be interpreted in light of the study limitations, including the retrospective nature, the use of invalidated surveys, small numbers, and high risk of assessor bias.

Nery et al (10) prospectively evaluated a similar method of treating lesser toe instability using a dorsal PPR and Weil's osteotomy; however, they also included soft tissue reefing with the lateral tissue. They analyzed a spectrum of plantar plate tears and graded the tears from 0 to IV. The repair technique for the plantar plate is almost identical to the method described by Gregg et al (12) and Weil et al (14), which

used drill holes in the proximal phalanx and passed a suture up through this from the distal end of the plantar plate. They assessed the results of 68 patients (100 lesser MTPJ procedures). Of these, 52 joints had grade 0, I, or IV tears as assessed using the Coughlin classification and were therefore not treated in a similar manner, which left 48 MTPJs for analysis (12,14). These joints were repaired using a dorsal approach and associated Weil's osteotomy. They used the visual analog scale to grade the pain pre- and postoperatively. The average score was 7.9 preoperatively and 1 postoperatively. The AOFAS scale scores improved an average of 41.5 points for those groups undergoing PPR (12,14). The joint stability, as assessed by the anterior drawer test, after surgery also improved. No joint was stable preoperatively and 33 were stabilized postoperatively, with the remainder having mild instability. Regarding the functional outcome, the investigators assessed the dynamic toe purchase with the ground (12,14). Preoperatively, 46 joints had an abnormal toe purchase compared with 19 joints with an abnormal toe purchase postoperatively. The obtained results from the included studies in the present review are listed in Table 2 (10,12–15).

Nery et al (10,15) argued that grading the type of tear allowed one to plan their management. They were the first to grade plantar plate tears and tailor the management plans accordingly. The results obtained from these 2 studies included in the present review (10,15) were grouped together because the same cohort was included in both studies.

Discussion

We identified 6 relevant studies with 162 patients for the present systematic review. These studies were separated into 2 groups according to the type of procedure conducted in each trial. Group A included studies in which the patients had undergone Weil's osteotomy and directive PPR using the dorsal approach (10,12,14,16,17). Group B included studies in which the participants had received PPR with FDL tendon transfer using the plantar approach (13).

Details of the recruitment strategies were not reported in any of the included studies. Different recruitment rates can result from different recruitment strategies. Each recruitment method will lead to a slightly different demographic of participants, which can potentially affect the clinical and psychosocial characteristics of the patient samples (18). Unrepresentative recruitment can lead to selection biases, which in turn can affect the treatment outcomes (19,20).

The inclusion criterion of the 6 included studies was a diagnosis of either lesser MTPJ instability or degenerative plantar plate rupture. Bouché and Heit (13) reported that 6 patients with a history of surgery on the affected foot were included in their study; however, no details about the previous interventions were provided. This could have caused a potential intervention bias on the outcomes achieved.

The exclusion criteria varied in the included studies. No details were reported on the exclusion criteria in the studies by Nery et al (16) or Yu et al (17). It is not clear whether the investigators missed

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