

Outcomes and Complications Associated with Lateral Column Lengthening Using Porous Titanium Wedges for Flexible Flatfoot Deformity Correction: A Systematic Review

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Statement of Purpose

Numerous graft materials have been utilized to achieve flexible flatfoot deformity correction via lateral column lengthening (LCL) including autograft, allograft, xenograft, and porous titanium wedges (PTWs). PTWs offer a potentially advantageous substitute for traditional grafts. Evidence regarding outcomes and complications of these grafts remains limited. This systematic review aims to describe functional outcomes and complications associated with LCL using PTWs.

Methods

This systematic review identified articles on LCL utilizing PTW for deformity correction which discussed outcomes as well as complications. A standard methodology for performing a systematic review was followed using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) guidelines. PubMed, Google Scholar, OVID, Embase, and Cochrane were searched on June 6, 2023. All publications with greater than 1-year follow-up, including LCLs performed with PTWs, were included. The following search criteria were performed: "Calcaneal lengthening osteotomy", "Flexible flatfoot", "Evans osteotomy", "Evans osteotomy graft", "Lateral column lengthening", "Porous titanium wedge". Limits were placed to include articles in the English language.

A total of **508 articles** were identified. Each article was reviewed by 1 of 5 junior authors. If there was a question if an article met the inclusion criteria, a second opinion was provided by the senior author (RM). After a thorough review of the pooled articles, 7 studies met the inclusion criteria. Data regarding functional outcomes as well as complications following LCL with PTWs were compiled by 5 researchers and accuracy was confirmed by the lead author.

Results

Of the included studies, four were level 4 evidence and two were level 3. A total of **246 LCLs with a PTWs was reported among 236 patients**. The average age of the patients at the time of the procedure was 40.9 years (9-74 years). The average follow-up was 28.1 months (6-43 months). The average BMI of the included patients was found to be 29.4 (27-30.2). The indication for the procedure was a stage II flexible flatfoot according to the previously described Johnson and Strom classification¹ in 100% (236/236) of the included patients.

☐ Reported ancillary procedures varied from study to study and are reported by **Table 1**

Ancillary Procedure Performed	No. of Patients
Cotton Osteotomy	92
Tendon Transfer	65
MCDO	51
PTT Debridement	32
Spring Ligament Repair	29
Posterior Muscle Group Lengthening	22
Medial Column Fusion	7
Distal Bunion Correction	2
Ankle Arthroscopy	1
Peroneus Brevis Repair	1
First MPJ Fusion	1

Table 1. Depicts the reported ancillary procedures performed in conjunction with LCL utilizing PTWs. A Cotton osteotomy was performed most often with LCL.

Outcome measures were reported in three studies.²⁻⁴ The Foot and Ankle Ability Measure (FAAM) was reported in 99 patients. The Visual Analog Scale (VAS) pain score was reported in 71 patients. **Table 2.** The FAAM Activities of Daily Living (ADL) score was measured post-operatively at 80.45 (80.0-80.9). Only Tsai et. al² reported preoperative values of FAAM ADL and Sports subscales at 56.0 and 31.25, respectively. FAAM Sports subscale was measured post-operatively at 58.5 (50.0-66.9). **Table 3.**

Article	No. of Patients	Pre-operative FAAM ADL/Sports Subscale Score	Post-operative FAAM ADL/Sports Subscale Score
Tsai et. al ²	45	56.0/31.25	80.0/50.0
Sequeira et. al ¹	54	Not reported	80.9/66.9
Total	99	56.0/31.25	80.45/58.5

Table 2. Outcome Measure - Reported FAAM ADL/Sport Subscale scores from included studies of patients undergoing LCL procedures with PTWs

Article	No. of Patients	Pre-operative VAS Pain Score	Post-operative VAS Pain Score
Gross et. al ⁴	26	5.0	1.6
Tsai et. al ²	45	5.9	3.0
Total	71	5.45	2.43

Table 3. Outcome Measure - VAS Pain Scores from included studies for patients undergoing LCL procedures with PTWs

Results Cont.

The overall complication rate utilizing PTWs for LCL was found to be **15.2% (36/236)**. Reported complications were further divided into major and minor complications. Major complications included non-union with or without reoperation due to non-union, development of deep infection, and chronic regional pain syndrome (CRPS). **Major complications occurred in 5/236 (2.1%) of included patients.** 3 (1.2%) patients requiring revision surgery to address the non-union/painful hardware. Minor complications included transient painful hardware, transfer pain, sinus tarsi syndrome, lateral column overload, lateral ankle pain, development of adjacent joint arthritis, and superficial wound complications. **Minor complications totaled 31/236 (13.1%) of included patients. Table 4**

Article	No. of Patients	No. of Complications	Complication
Moore et. al ⁵	30	7	Lateral Column Overload (5) Sinus Tarsi Syndrome (2)
Gross et. al ⁴	26	4	Non-union (1) Lateral Ankle Pain (2) Subtalar Joint Arthritis (1)
Schleunes et. al ⁷	34	14	Adjacent Joint Arthritis (5- did not state joint) Sinus Tarsi Syndrome (4) Lateral Column Overload (3) Superficial wound infection (2)
Sequeira et. al ³	54	1	Non-union (1)
Matthews et al ⁶	30	4	Transfer Pain (2) Painful Hardware (2)
Tsai et. al ²	45	3	Non-union (2) CRPS (1)
Stamatos et. al ⁸	17	3	Lateral Column Overload (2) Superficial Wound Infection (1)
Total	236	36 (15.2%)	

Table 4. Reported complications with LCL procedures utilizing PTWs in reported studies included in systematic review. **Bold represents major complication**

Analysis and Discussion

Numerous studies have compared the outcomes and complications of autograft versus allograft wedges used for LCL procedures,^{6,9,10} with autograft harvest from the iliac crest previously described as the "gold standard."¹⁰ In recent years, surgeons have utilized PTW grafts, rather than iliac crest autograft or allograft, in hopes of diminishing non-union rates and donor site morbidity.²⁻⁸ There is currently a paucity of literature describing the outcomes and complications associated with LCL with a PTW. To our knowledge, we present the first systematic review on PTW usage for LCL.

We found that postoperative outcome scores for LCL with PTWs are underreported²⁻⁴ but are similar to commonly utilized allograft wedges¹¹, while a higher BMI and lower preoperative hindfoot valgus may negatively influence these outcomes.³

Within our systematic review of PTWs for LCL, our overall complication rate was 15.2% (36/236), with 5 (2.1%) major complications, and 31 (13.1%) minor complications. Among the 236 patients in this review, 4 patients (1.7%) demonstrated a non-union at the graft site. This rate is similar to the 1.4% non-union rate among 73 patients reported by Prissel et. al among unfixed LCL procedures using allograft or autograft wedges.¹²

Despite promising findings, it is important to acknowledge the limitations of this review, including the relatively small number of included studies and the variability in reporting radiographic outcomes. However, the evidence from this systematic review suggests that LCL with PTWs can be an effective and viable option for correcting flexible flatfoot deformities. The use of PTWs appears to offer comparable functional results and complication rates to traditional allograft or autograft wedges based on current literature.

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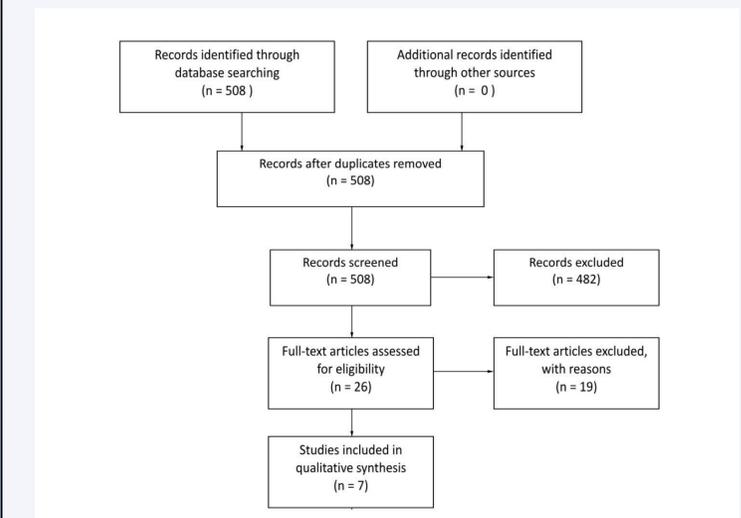


Figure 1. Systematic review methodology according to PRISMA guidelines. PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses