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# Effect of Prior Cheilectomy on Outcomes of First Metatarsophalangeal Joint Fusion for Treatment of Hallux Rigidus

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## Abstract

**Background:** Patients with hallux rigidus who do not experience significant pain relief after cheilectomy often require a conversion to metatarsophalangeal (MTP) fusion. However, it is unclear whether the previous cheilectomy affects outcomes of the subsequent fusion. The aim of this study was to compare patient-reported outcomes and complications in patients undergoing MTP fusion for hallux rigidus between patients with a history of cheilectomy and those undergoing a fusion as a primary procedure.

**Methods:** This retrospective cohort study included patients who underwent MTP fusion who had preoperative and minimum 1-year postoperative Patient Reported Outcomes Measurement Information System (PROMIS) scores. Patients were divided into a "primary MTP fusion" cohort and a "prior cheilectomy" cohort based on their history of a previous cheilectomy. Preoperative, postoperative, and improvement in PROMIS scores, along with rates of complications including nonunion, infection, interphalangeal (IP) joint pain, and removal of hardware were compared between groups.

**Results:** The prior cheilectomy group had significantly lower preoperative physical function scores than the primary MTP fusion group ($P < .05$). Postoperatively, the prior cheilectomy group had worse physical function ($P < .017$) and global physical health ($P < .017$) scores. However, there were no significant differences in pre- to postoperative change in PROMIS scores. There were no significant differences in rates of nonunion ($P = .99$), infection ($P = .99$), or hardware removal ($P = .99$). More patients in the prior cheilectomy group had IP joint pain ($P = .034$).

**Conclusion:** This study found that a prior cheilectomy may not affect serious complication rates of a subsequent fusion, but it may be associated with worse baseline function. Overall, our results suggest that a prior failed cheilectomy does not influence the amount of improvement in function and pain from MTP fusion.

**Level of Evidence:** Level III, retrospective cohort study.

**Keywords:** hallux rigidus, cheilectomy, revision, metatarsophalangeal fusion, patient-reported outcomes, PROMIS

## Introduction

Hallux rigidus is a condition of degenerative arthritis at the first great toe metatarsophalangeal (MTP) joint that can cause significant great toe pain and restricted motion. When conservative treatment strategies fail, operative treatment of hallux rigidus involves either joint-sparing procedures such as cheilectomy with or without Moberg osteotomy, interposition arthroplasty, and synthetic cartilage implantation or joint-sacrificing such as first MTP arthrodesis.[8,17] The choice of surgical treatment is based on a combination of symptom severity and character, radiographic severity of joint space changes, and importantly, the patient's postoperative goals.[16] Cheilectomy with or without Moberg osteotomy improves pain caused

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**Table 1.** Demographics.

| | Primary MTP Fusion (n=95) | Prior Cheilectomy (n=27) | *P* Value |
|---|---|---|---|
| Age, y, mean (SD) | 61.1 (9.4) | 58.5 (10.3) | .32 |
| BMI, mean (SD) | 26.5 (4.9) | 25 (3.1) | .24 |
| Gender, n (%) | | | |
| Female | 38 (40) | 6 (22.0) | .11 |
| Male | 57 (60) | 21 (77.8) | |
| Time from cheilectomy to fusion, mo | – | 11.2 | – |

Abbreviations: BMI, body mass index; MTP, metatarsophalangeal.

by dorsal osteophytes and improves dorsiflexion range of motion.[20] Cheilectomy is often performed in an open technique with a saw, but it may also be formed in a minimally invasive fashion using a burr. The amount of resection of the metatarsal head is also variable and dependent on surgeon preference. Although it is generally chosen for earlier stages of hallux rigidus, more recent studies have suggested its potential for managing advanced disease as well.[18,20]

Despite good results and a low reported incidence of revision after cheilectomy,[8,10,19] some patients may eventually require conversion to MTP fusion because of inadequate pain relief from the cheilectomy.[4,7,23] Although primary MTP fusion has yielded excellent results in the literature,[7-9,12,21,25] a prior cheilectomy may adversely affect secondary fusion procedures secondary to loss of bone stock at the hallux metatarsal head, advanced degenerative change,[6] soft tissue scarring, and impaired blood flow, which theoretically increase the risk of nonunion. A better understanding of whether previous cheilectomy affects outcomes of the subsequent fusion is key to determining the choice of treatment for hallux rigidus and setting patient expectations for postoperative function and pain.

The primary objective of this study was to determine if a prior cheilectomy influenced complication rates and clinical outcomes for patients treated with MTP fusion. Union rate, complication rates, and patient-reported outcomes were compared between patients with hallux rigidus undergoing primary MTP fusion (without any prior surgery to the toe) and patients undergoing MTP fusion with a history of a cheilectomy. We hypothesized that patients with prior cheilectomy would experience worse clinical outcomes and higher rates of complications after MTP fusion. A secondary objective of this study was to determine if time between the initial cheilectomy and subsequent fusion was associated with postoperative PROMIS scores. The goal was to assess whether time between the 2 procedures (ie, more time for arthritis progression) was related to outcomes of the MTP fusion. We hypothesized that a longer time between cheilectomy and fusion would be associated with worse PROMIS scores.

## Methods

### *Patient Cohort*

This retrospective comparative cohort study was approved by an institutional review board (IRB)–approved orthopaedic foot and ankle registry steering committee of prospectively collected surgical data at the authors' home institution. Patients with a diagnosis of hallux rigidus who were surgically treated by one of 10 fellowship-trained foot and ankle surgeons with first MTP fusion between June 2016 and January 2021 were retrospectively identified from the registry database. Patients were eligible for inclusion in this study if they were 18 years or older and had a minimum 1-year clinical follow-up.

A total of 232 feet in 229 patients were identified by our initial registry database search. Sixty-two feet were excluded for prior bunionectomy procedure, and 23 due to preoperative severe hallux valgus deformity since we wished to study patients with isolated hallux rigidus without an arthritic bunion. Fifteen were excluded for history of great toe arthroplasty, 6 due to diagnosis of rheumatoid arthritis, 3 for diagnosis of gout, and 1 due to simultaneous ankle arthroscopic procedure. This left 122 feet in 112 patients in the final cohort.

Patients in the final cohort who had a history of cheilectomy before MTP fusion were identified using the electronic medical record. Patients who underwent primary MTP fusion were allocated to a "primary fusion" group, and patients with history of cheilectomy were allocated to a "prior cheilectomy" group. The primary fusion group had 95 patients with mean age of 62 (SD, 9.4) years and average body mass index (BMI) of 26.5 (SD, 4.9). The prior cheilectomy group had 27 patients, with a mean age of 58.5 (SD, 10.3) years and average BMI of 25 (SD, 3.1). The average time from cheilectomy to MTP fusion in this group was 11.2 months. Two patients had their cheilectomy done at the authors' institution, and the other 25 had the cheilectomy performed at an outside institution. There were no differences in demographic data between groups (Table 1). Preoperative radiographs were analyzed to assess severity of hallux rigidus using the Coughlin and Shurnas classification system.[5] All patients in the study had radiographic

**Figure 1.** All patients in the study cohort exhibited radiographic grade 3 hallux rigidus according to the Coughlin and Shurnas classification system.

grade 3 hallux rigidus (Figure 1). Although there were likely many cases of grade 4 hallux rigidus, the difference between grade 3 and grade 4 is purely a clinical difference based on physical examination findings, which we did not prospectively collect and record for each patient.

## *Surgical Technique and Postoperative Protocol*

An incision was made over the dorsal aspect of the first MTP joint and dissection was done allowing visualization of the MTP joint. Osteophytes were removed. Each side of the joint was prepared with cup-and-cone reamers, fenestrated with a 1.6 Kirschner wire, and fish-scaled with an osteotome. The joint was provisionally pinned and radiographs were checked for appropriate position with slight valgus, neutral rotation, and dorsiflexion with the toe just at the ground. The method of fixation was a plate-and-screw construct in all cases. An MTP fusion plate was bent into position and placed on the dorsal aspect of the joint. The plate was pinned and radiographs were checked for position. The 2 distal screws were drilled and placed. A proximal oblong hole was drilled eccentrically and compression was obtained, and the proximal screw holes were filled. The crossing screw was then placed. After fixation, the position of the hardware and joint was confirmed using intraoperative fluoroscopy. The capsule, subcutaneous layer, and skin were then closed. Postoperatively, patients were nonweightbearing for 4 weeks, with a postoperative splint for 2 weeks and a controlled ankle motion (CAM) walker boot for another 2 weeks. Patients then began progressively increasing partial weightbearing. Formal physical therapy was started at this point.

## *Clinical Outcomes and Complications*

Patient-reported outcomes were assessed using PROMIS questionnaires, which use computerized adaptive testing (CAT) based on item response theory and have been validated for use in foot and ankle research.[1,14] Surveys were administered to patients preoperatively and at a minimum of 1 year postoperatively from 6 domains: Physical Function CAT, Pain Interference CAT, Pain Intensity Short Form (SF) 3a, Global Physical Health SF, Global Mental Health SF, and Depression CAT. Higher PROMIS scores in the physical function, global physical health, and global mental health domains indicate better outcomes, whereas lower scores in the pain interference, pain intensity, and depression domains indicate better outcomes. Scores from these surveys were recorded on the registry database as *t* scores with a mean of 50 and an SD of 10. Preoperative, postoperative, and pre- to postoperative changes in PROMIS scores were compared between the primary MTP fusion group and the prior joint-sparing surgery group. The average follow-up for postoperative PROMIS scores was 18.8 months for the entire cohort, 17.9 months for the primary MTP group, and 22 months for the prior cheilectomy group ($P = .19$).

Complications including nonunion (defined as failure to reach bony union by 6 months postoperatively), infection,

**Table 2.** Preoperative PROMIS Scores.[a]

| PROMIS Domain | Primary MTP Fusion (n=95) | Prior Cheilectomy (n=27) | *P* Value |
|---|---|---|---|
| Physical Function | 44.4 (7.1) | 40.6 (7.6) | .028 |
| Pain Interference | 58.5 (5.4) | 60.4 (7.3) | .089 |
| Pain Intensity | 50.1 (5.2) | 51.3 (5.8) | .21 |
| Global Physical Health | 47 (6.9) | 44.7 (6.5) | .22 |
| Global Mental Health | 53.9 (8.4) | 50.8 (12.1) | .34 |
| Depression | 48.3 (7.2) | 46.4 (9.3) | .63 |

Abbreviations: MTP, metatarsophalangeal; PROMIS, Patient Reported Outcomes Measurement Information System.
[a]Data are reported as mean (SD).

interphalangeal (IP) joint pain due to arthrosis or overload, and removal of hardware were recorded for each patient through review of medical records. Rates of each complication were compared between groups.

### *Statistical Methods*

The Shapiro-Wilk test was applied to check the normality of the continuous variables. Mean and SD or median and interquartile range were summarized for continuous variables depending on the normality of their distribution. Count and percentage were calculated for discrete variables. For demographic and complication comparisons, Mann-Whitney *U* tests were applied for continuous variables, and Fisher exact test was used for discrete variables. Preoperative PROMIS scores were compared using Mann-Whitney *U* tests to look for baseline differences. Wilcoxon signed-rank tests were used to assess improvement in preoperative to postoperative scores in both groups. Postoperative PROMIS scores were compared between the primary fusion group and the prior cheilectomy group using multivariable linear regression, controlling for age, BMI, gender, and preoperative PROMIS scores. In the prior cheilectomy group, a subgroup analysis was performed to determine if preoperative to postoperative change in PROMIS scores were associated with time from cheilectomy to MTP fusion using univariable regression models. Statistical significance was defined as $P < .05$. All analyses were conducted using SAS, version 9.4, software.

## Results

### *Patient-Reported Outcomes*

The preoperative PROMIS Physical Function score was significantly lower in the prior cheilectomy group (mean 40.6, SD 7.7) compared to the primary MTP fusion group (mean 44.4, SD 7.1) ($P < .05$). No other preoperative PROMIS scores were significantly different between the 2 cohorts (Table 2). In the primary MTP fusion group, significant improvements were seen in the Physical Function, Pain Interference, Pain Intensity, and Global Physical Health domains (all $P < .001$) (Figure 2). The prior cheilectomy group also had improved Physical Function ($P = .005$), Pain Interference ($P < .001$), and Pain Intensity ($P < .001$) domains, but not Global Physical Health (Figure 3).

Assessment of postoperative scores demonstrated significant differences between groups in the Physical Function and Global Physical Health domains. The prior cheilectomy group had significantly worse outcomes in the Physical Function ($P = .017$) and Global Physical Health ($P = .017$) domains (Table 3).

In comparing the 2 groups, there were no significant differences in preoperative to postoperative score improvement for any PROMIS domain (Figure 4).

### *Complications*

Nonunion of the MTP fusion occurred in 3 patients in the primary MTP fusion group (3.2%) and 1 patient in the prior cheilectomy group (3.7%), with no significant differences in incidence ($P = .99$). All 3 patients in the primary MTP fusion group went on to have revision MTP fusion with successful union, whereas the patient from the prior cheilectomy group decided against revision surgery.

One case of cellulitis at the surgical site occurred in the primary MTP fusion group (1.1%) 5 months postoperatively, which resolved with oral antibiotics, and there were no infections in the prior cheilectomy group ($P = .99$). Twelve patients (12.6%) in the primary MTP fusion group and 4 patients in the prior cheilectomy group (14.8%) underwent hardware removal for symptomatic hardware ($P = .99$). A total of 4 patients developed postoperative pain at the interphalangeal (IP) joint. One patient belonged to the primary MTP fusion group (1.1%) and underwent subsequent MTP dorsiflexion osteotomy at the arthrodesis site. Three were in the prior cheilectomy group (11.1%), one of whom was found to have significant arthrosis radiographically and went on to have an IP fusion, which resolved the pain. The other 2 did not have radiographic evidence of arthrosis or arthritis but still reported continued joint pain. The incidence of IP joint pain was higher in the prior cheilectomy group ($P = .034$).

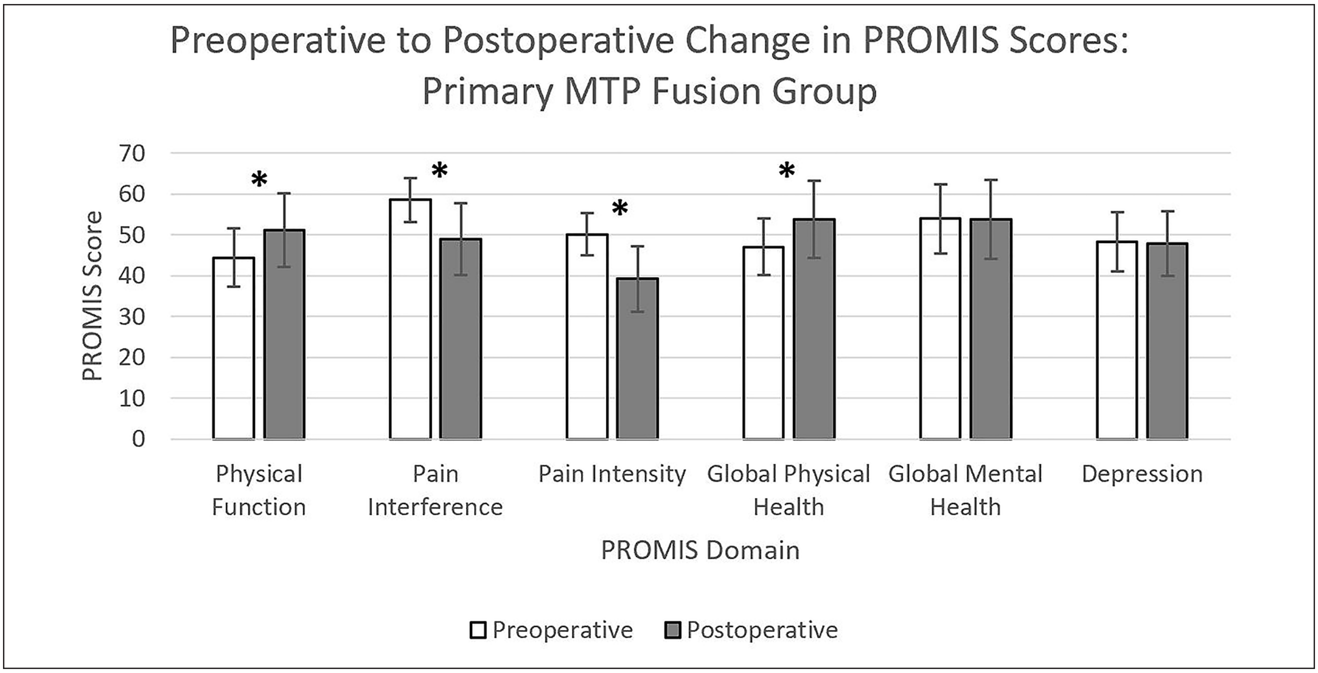


**Figure 2.** Preoperative to Postoperative Change in PROMIS Scores in the primary MTP fusion group. Significant improvements were noted in the Physical Function, Pain Interference, Pain Intensity, and Global Physical Health domains (all $P < .001$), as indicated by the asterisk.

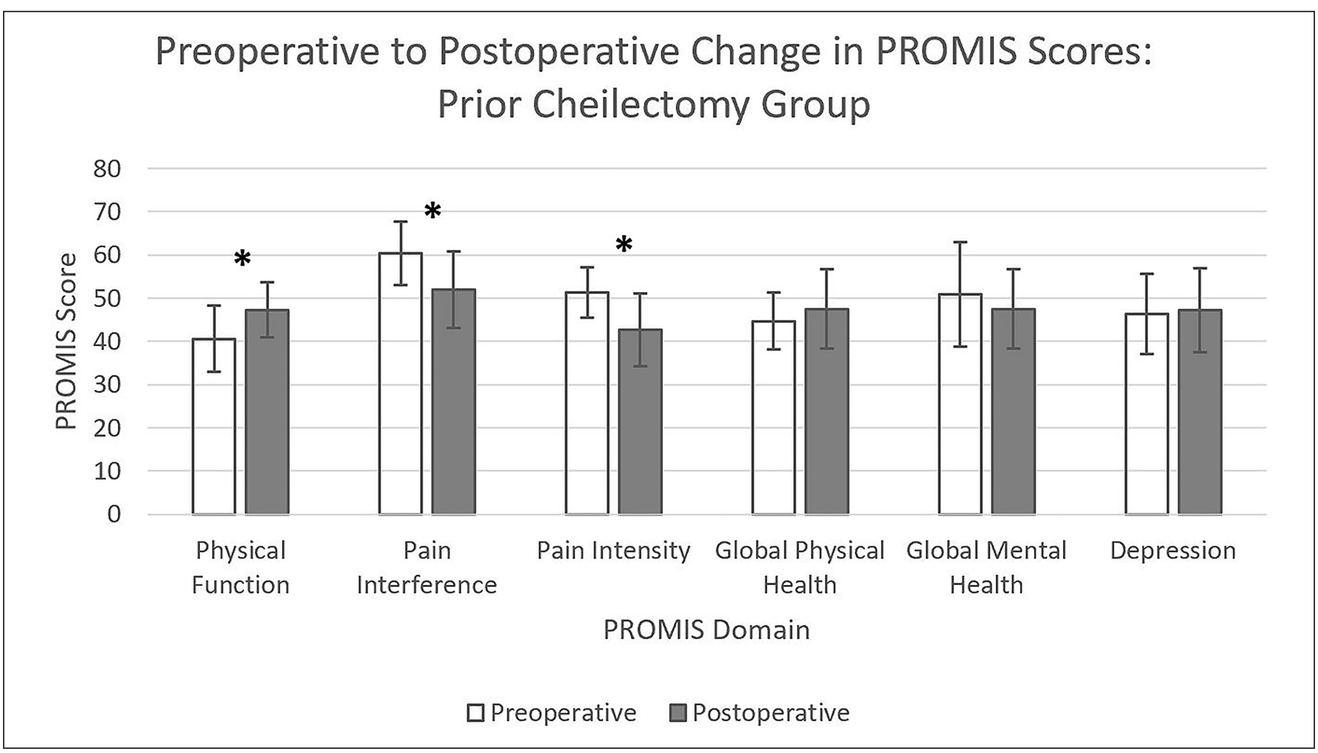


**Figure 3.** Preoperative to Postoperative Change in PROMIS Scores in the prior cheilectomy group. Significant improvements were noted in the Physical Function ($P = .005$), Pain Interference ($P < .001$), and Pain Intensity ($P < .001$) domains, as indicated by the asterisk.

**Table 3.** Postoperative PROMIS Scores.[a]

| PROMIS Domain | Primary MTP Fusion (n=95) | Prior Cheilectomy (n=27) | *P* Value[b] |
|---|---|---|---|
| Physical Function | 51.2 (9.0) | 47.3 (6.3) | .017 |
| Pain Interference | 49 (8.8) | 52 (8.8) | .27 |
| Pain Intensity | 39.2 (8.9) | 42.6 (8.4) | .14 |
| Global Physical Health | 53.8 (9.5) | 47.5 (9.1) | .017 |
| Global Mental Health | 53.7 (9.7) | 51.9 (10.3) | .74 |
| Depression | 47.8 (7.9) | 47.2 (9.7) | .70 |

Abbreviations: MTP, metatarsophalangeal; PROMIS, Patient Reported Outcomes Measurement Information System.
[a]Data are reported as mean (SD).
[b]*P* values from multivariable regression analysis adjusting for age, body mass index, gender, and preoperative PROMIS score.

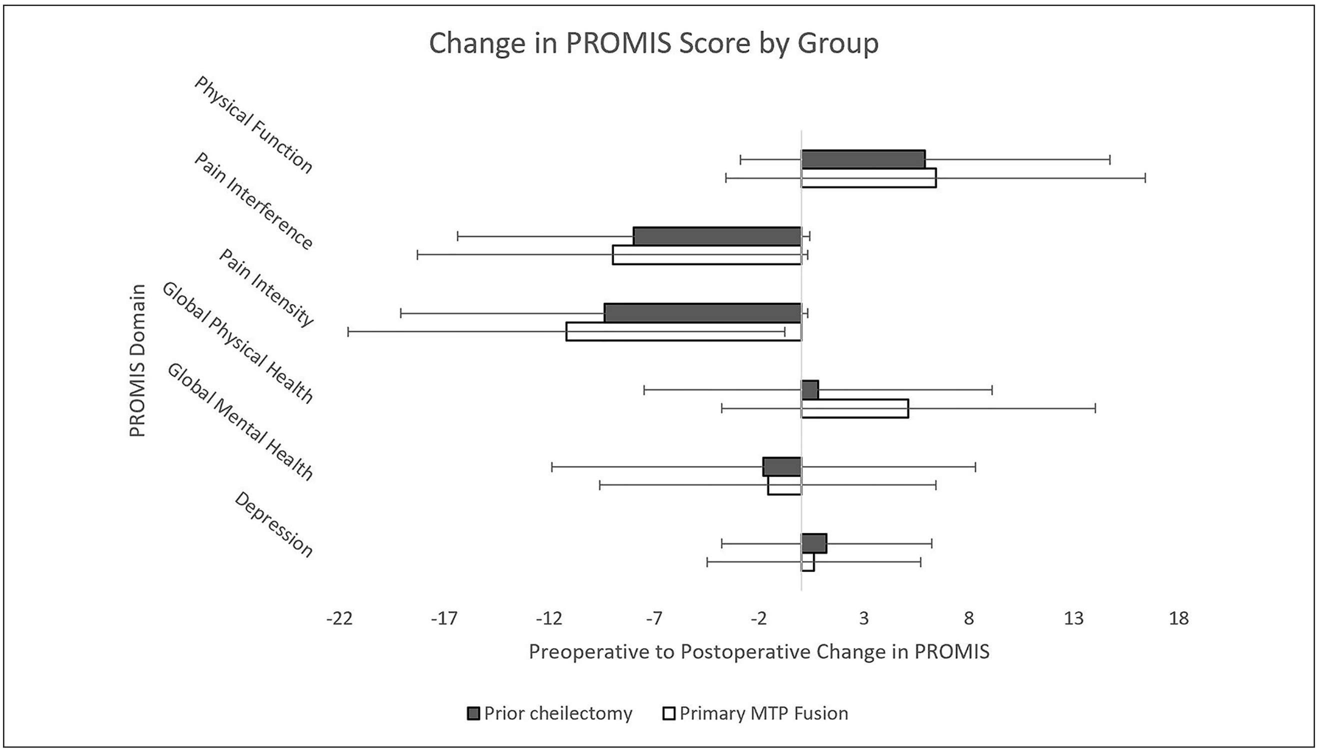


**Figure 4.** Comparison of amount of improvement in PROMIS scores between primary MTP fusion and prior cheilectomy groups. No significant differences were found in any PROMIS domain.

### *Subgroup Analysis*

Subgroup analysis of the relationship between time from cheilectomy to MTP fusion and preoperative to postoperative change in PROMIS scores resulted in no significant associations found in any PROMIS domain (all $P > .05$).

## Discussion

In this study, we investigated whether a prior cheilectomy affected patient-reported outcomes and complications of hallux MTP fusion for hallux rigidus. Our results demonstrated that the prior cheilectomy patients started with worse PROMIS physical function scores. Although postoperative PROMIS physical function and global physical health scores remained worse than fusion patients without previous surgery, both groups experienced similar notable clinical improvement. These findings suggest that a history of cheilectomy may not adversely affect the improvements seen after subsequent fusion. There were no differences in the incidence of postoperative nonunion; however, the prior cheilectomy group had an incidentally higher rate of postoperative IP joint pain.

It is difficult to ascertain why cheilectomy patients had lower physical function scores, both pre- and postoperatively. We propose that failure to meet expectations after their initial cheilectomy may have negatively affected preoperative scores. Fulfillment of operative expectations has been shown to be correlated with patient-reported outcome scores, postoperative complications, and need for revision surgery in previous studies.[3,11] Interestingly, as demonstrated by the majority of patients in our prior cheilectomy cohort, patients who are unhappy with cheilectomy may often seek care with a different surgeon, likely because of the failure to fulfill expectations. Additionally, it is possible that the patients who required conversion to fusion had greater severity of hallux rigidus at baseline and may have been poor candidates for cheilectomy. In their cohort of cheilectomy patients, Coughlin and Shurnas reported that 5 of 7 failed cheilectomies that required subsequent arthrodesis were patients with grade 4 changes.[5] Further, the patients were originally advised to undergo MTP fusion, but elected to undergo a cheilectomy instead.[5] This may have been the case with our cohort; however, we were unable to radiographically assess hallux rigidus severity prior to cheilectomy because the cheilectomies were often done outside of our institution.

Postoperatively, it is possible that the higher incidence of great toe IP joint pain, along with other factors such as excess scar tissues from multiple procedures, may explain the lower functional scores. However, because we found that the amount of improvement after MTP fusion was similar between groups, this explanation is less likely. Rather, the preoperative functional deficits of the prior cheilectomy group, demonstrated by their worse preoperative physical function scores, most likely contributed to the worse postoperative PROMIS scores. These patients may be starting from a lower functional baseline after their failed cheilectomy, which can affect their postoperative outcome after MTP fusion. The difference in postoperative Global Physical Health scores may reflect the differences in Physical Function scores, as both surveys ask similar questions regarding patients' ability to carry out their activities of daily living and other functional tasks. However, the Physical Function CAT may be more specific to functional disability because it is a more extensive survey that uses item response theory. For this reason, we hypothesize that the Global Physical Health survey may not have been specific and extensive enough to capture functional differences found in the Physical Function survey preoperatively, but it was able to detect the difference postoperatively.

Although the prior cheilectomy patients had worse preoperative and postoperative functional scores, our results indicated that both groups showed significant improvements in all PROMIS domains, demonstrating that an MTP fusion can still lead to clinically significant improvements despite a history of prior procedures. The improvements were comparable to outcomes reported in the literature after MTP fusion, as previous studies also found significant improvement in PROMIS physical function at 38 months' follow-up, which lends to the validity of our analysis.[15] The improvements seen in our study cohorts were also clinically significant when compared to estimated minimal clinically important difference (MCID) values of 4.5 for PROMIS physical function and 4.1 for PROMIS pain interference in a study of patients undergoing foot and ankle surgery.[13] Although there are no studies specifically estimating MCIDs after an MTP fusion, MCIDs for cheilectomy in patients with hallux rigidus have been reported.[22] The MCIDs for Physical Function and Pain Interference were both 4.2,[22] and both groups exceeded this amount of improvement in both PROMIS domains. Clinically, our results do not suggest that surgeons should be more aggressive with primary fusion instead of cheilectomy. The benefits of a cheilectomy are well documented, even for cases of severe hallux rigidus.[20] We believe that treatment options should continue to be individualized for patients based on their severity, preoperative dysfunction, and postoperative goals.

Although many studies have documented revision rates after cheilectomy, there have not been any descriptions of outcomes after revision surgery that could support our findings. A systematic review by Roukis[23] examined the need for surgical revision after a cheilectomy, reporting a low overall incidence of revision (8.8%) at minimum 12 months postoperatively. Other studies corroborate these results, with retrospective analyses by Sidon et al[24] and Maes et al[18] finding low revision rates of 5% and 1%, respectively, after cheilectomy. Although they do not present evidence on outcomes of revision, the authors clinically agreed that cheilectomy does not preclude later arthrodesis. Our analysis supports this idea, but also suggests that this topic may need to be studied further. The incidence of serious complications in our study was not significantly higher in the prior cheilectomy group, and there was significant improvement in several PROMIS domains, indicating that an arthrodesis is a safe and reliable option after a failed cheilectomy. However, patients with a history of failed cheilectomy may not reach a comparable level of function postoperatively as those undergoing primary fusion. Because cheilectomy does not appear completely benign, it is important to thoroughly assess patients' clinical and radiographic severity along with risk factors for failure, and to inform them of its impact on possible conversion to fusion.

We found no differences in incidence of complications such as nonunion between groups. A cheilectomy, which reduces bone stock and potentially impairs blood supply around the metatarsal head, may theoretically increase the risk of nonunion with subsequent arthrodesis. Although we hypothesized that these complications may be observed more frequently in the cheilectomy group, our analysis revealed low, comparable rates of nonunion. Additionally, we observed that IP joint pain and arthrosis was more common in the prior cheilectomy group. Although we did not measure the length of the first metatarsal in this study, the prior cheilectomy itself or progression of arthritis between the cheilectomy and fusion might have resulted in a shortened first ray and contributed to frequent IP joint complications. This may also be related to increased time between the cheilectomy and fusion, with more time for the arthritis to progress and potentially affect outcomes of the fusion, which is why the subgroup analysis was performed. However, we did not find any association between time from cheilectomy to fusion and postoperative PROMIS scores, making this explanation less likely.

This study has several limitations, starting with its retrospective nature and small sample size of 27 feet in the cheilectomy group, which seems consistent with the overall low rate of revision after cheilectomy.[2,4,5] Additionally, the cheilectomy group is likely underpowered to detect an association for our secondary aim of the relationship between time from cheilectomy to fusion, and postoperative PROMIS scores, and a power analysis was not performed for this study, although data to perform a post hoc analysis is available. Because it is difficult to acquire a large number of eligible patients from 1 institution, future studies could involve multicenter recruitment to gain more robust data on this topic. Selection bias may have been present in the prior cheilectomy group because these patients may have been unsatisfied or significantly limited to seek consultation for another surgery. The majority of patients are satisfied after a cheilectomy and may not need another procedure.[10,18-20] Another limitation is our lack of objective radiographic data to compare the severity of hallux rigidus before the initial cheilectomy in the prior cheilectomy group. Although all patients were grade 3 radiographically prior to the MTP fusion, it is possible that one group had worse arthritis as grading also contains a clinical component that was not able to be assessed because of the retrospective nature of the study. Thus, there is potential for selection bias in our cheilectomy group because these patients may have had greater severity of hallux rigidus to begin with. We also do lack patient-reported outcome data prior to the cheilectomy, because of the retrospective nature of our study combined with many cheilectomies being performed outside of our institution. Finally, the significant difference in preoperative PROMIS Physical Function between groups present another limitation, because this would influence the statistically significant difference we found in postoperative Physical Function. Therefore, we encourage readers to place greater importance on the comparisons in preoperative to postoperative change in PROMIS scores between groups, rather than the postoperative scores themselves.

## Conclusion

This study investigated clinical outcomes of MTP fusion in patients with a history of cheilectomy compared to those undergoing a primary fusion for hallux rigidus. Overall, our results suggest that a prior failed cheilectomy does not influence complications or the amount of improvement in function and pain from MTP fusion, which was clinically significant in both groups. Although patients with prior cheilectomy had lower postoperative physical function and global physical health scores, this may be associated with a lower baseline in those patients, demonstrating the need for further research to investigate if there truly is lower baseline after a failed cheilectomy, and potential reasons for this finding. We support that individualized counseling and setting operative expectations remains clinically relevant for each patient presenting with hallux rigidus, and that choice of operative treatment is centered around patients' dysfunction, severity of hallux rigidus, and postoperative goals.

### Ethical Approval

Ethical approval for this study was obtained from the Foot and Ankle Registry Steering Committee of the authors' institution (IRB 2013-038).

### Declaration of Conflicting Interests

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