

Original Research

Bilateral Tarsal Coalitions: Are Postoperative Outcomes Different From Unilateral?

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Abstract:

Purpose: The purpose of this prospective study was to assess and compare clinical outcomes for patients with bilateral tarsal coalitions who had at least one coalition treated with surgical excision.

Method: Patients were identified prospectively and agreed to participate. Data was collected prior to surgery and again after surgery for up to 2 years. Comparisons of patients with unilateral disease to bilateral disease as well as unilateral excision to bilateral staggered and bilateral concomitant excision was done.

Results: Initial cohort included 55 patients with 70 feet containing a tarsal coalition. 30 patients with 45 feet had bilateral tarsal coalition excision during the study period. Postoperative outcomes were considerably improved from preoperative outcomes. Five bilateral patients had concomitant excision, and 10 had staggered surgery. There was no difference in outcome from patients with unilateral disease when compared with bilateral disease. There was no difference in patients with bilateral disease who had only one side excised compared to those that had both sides excised, and there was no difference in outcome for patients with staggered surgery compared to those with concomitant surgery.

Conclusions: Patients with bilateral tarsal coalition show improvement in their outcomes in a similar fashion to those with unilateral disease. Concomitant surgical outcomes are comparable to staggered outcomes in this group, although the series is small.

Level of Evidence: Therapeutic Level 2

Key Concepts:

- Patients undergoing surgery for bilateral tarsal coalition have similar patient-based outcomes to those with a unilateral process both before and after surgery.
- Some patients chose to have surgery on only one side, and they trend toward inferior outcomes in the postoperative foot from those who proceed with bilateral surgery.
- Concomitant surgery (under one anesthesia) for bilateral tarsal coalition has similar outcomes to those done in a staged fashion and can be considered for a more rapid return to activities.

Background

Tarsal coalition is an abnormal connection between two bones of the hindfoot causing rigidity and sometimes pain. The most common coalitions involve the calcaneonavicular (CN) joint and the talocalcaneal (subtalar, ST) medial facet joint, but other symptomatic coalitions have been reported as well.¹ Bilateral tarsal coalitions (TC) are found in up to 50% of patients with tarsal coalition but may not always be symptomatic concurrently.^{2,3} Even in patients with unilateral subtalar coalitions, the contralateral hindfoot bones may still be abnormal, indicating some bilateral tendencies in formation.⁴ Initial treatment of tarsal coalition is typically conservative, but if there is failure of conservative measures, surgery is often recommended. Surgery usually involves excision of the abnormal coalition, but other procedures can be performed as well.¹

Studies investigating tarsal coalition typically pool data from both unilateral and bilateral tarsal coalitions.^{5,6} Bilateral tarsal coalitions may have some unique features; however, these have not yet been independently explored. We reported previously⁷ on some bilateral coalitions that had only one foot treated surgically, which suggested that patient-reported outcomes were lower than when both coalitions were excised. We could not determine from that data if the postoperative foot continued to hurt, and therefore, patients didn't wish to pursue the contralateral excision or if the nonoperative foot hurt, but the patient did not schedule excision on that foot. Furthermore, some patients have bilateral coalitions

that are excised simultaneously. How do these patients do when compared to those with staggered excisions? Finally, in the total joint literature, patients report more satisfaction after their second joint replacement rather than after their first.⁸ Does this also hold true for staggered bilateral tarsal coalition excision?

The purpose of this prospective study was to assess and compare the patient-based results, before and after surgery for coalition excision, of patients with bilateral tarsal coalitions. Patient outcomes were compared for those with bilateral excision of their coalitions versus unilateral excision and simultaneous excision versus staggered excision. Preoperative pain in the presence of bilateral coalitions versus unilateral coalitions was compared as well as patient-based outcomes after 1st side of staggered coalition excision versus 2nd side of staggered coalition excision.

Methods

Institutional Review Board approval was achieved before initiation of this study. Informed consent was obtained from all participants.

This prospective study utilized a cohort of patients previously described.⁹ Patients were identified when scheduled for excision of their tarsal coalition during the study period. If patients met inclusion criteria and not the exclusion criteria, research personnel approached them preoperatively for inclusion in the study. If patients declined, they had no further involvement in the study.

If they agreed, then informed consent for inclusion in the study was completed and the patients filled out the preoperative forms which included (1) University of California Los Angeles (UCLA) activity score¹⁰ (score 0 to 10 with higher score equivalent with greater level of athletic participation), (2) modified American Orthopaedic Foot and Ankle Society score (mAOFAS) completed by foot¹¹ (score of 0 to 100 with high number equivalent to better outcome), and (3) the question, “Is your activity limited by your foot pain?”, which was completed for each foot. Patients were then assessed with similar questionnaires at 6, 12, and 24 months postoperatively. If they returned for contralateral tarsal coalition excision in the study window, they would again fill out the same questionnaires.

Patients aged 18 years or younger treated surgically for either unilateral or bilateral tarsal coalition were included in the study. Patients with bilateral coalitions who already had one coalition excised prior to the study could be included for their second (contralateral) coalition excision. Patients with syndromic conditions, non-English speakers, those treated for foot conditions other than tarsal coalition, and those with the presence of a clubfoot or hemimelia were excluded from the study.

In addition to patient-based outcome questionnaires, additional patient information was collected and recorded. This included simple demographic and clinical data, including side(s) of surgery, type of coalition, any complications or problems postoperatively, and clinical follow-up. Radiographic results were not included.

Prior to the initiation of this prospective study, power analysis was completed for the clinical results and reported previously.⁹ Statistical significance was set to $p < 0.05$ (2-tailed). Continuous data were age (years), UCLA activity score (linearity assumed), modified AOFAS score (linearity assumed), and time since surgery (months). Data were compared between groups using Student *t* test or the Wilcoxon rank-sum test as appropriate. Dichotomous data included sex, type of coalition (CN or TC), unilateral versus bilateral, right versus left, foot with completion of tarsal coalition

excision versus foot with coalition still present, and activity limited by foot pain (yes or no, left or right). Dichotomous data were then compared using Fisher exact test or Chi Square as appropriate. Comparisons were done in Excel software (Microsoft Corp., Redmond, WA) and GraphPad Prism version 7.00 for Mac (GraphPad Software, La Jolla, CA, www.graphpad.com).

For assessment of patient outcomes, we utilized data at 24 months if available. If not, then 12-month data was used and if not, then 6-month data was used. If no postop data was available, this was noted as missing data.

Comparisons were done on patient-based outcomes (UCLA activity score, modified AOFAS, and question regarding foot pain during activity) between bilateral coalitions (TC excised on both feet) and those with bilateral coalition but only one side excised, between those with bilateral and unilateral coalitions, and between those with bilateral coalitions who had staggered surgery versus those with concomitant surgery. Of the patients with bilateral coalition, results after the first surgery were compared to results after the second to see if perceptions after the first or second surgery were different.

Results

The original cohort (including patients with unilateral disease) included 55 patients with 70 feet containing a tarsal coalition treated with excision during the study period. This cohort has been reported on previously, in total⁹ and in part.¹² Of the 70 feet with tarsal coalitions, 39% (27/70) were noted to have ST coalitions, 53% (37/70) were noted to have CN coalitions, 5% (4/70) were noted to have both ST and CN coalitions, and 3% (2/70) were noted to have other types of coalitions. Follow-up, including only the second side of patients treated bilaterally, averaged 26 months (range 6-67 months, SD 10 months) (Figure 1).

Bilateral tarsal coalitions treated during the study period were noted in 45 feet in 30 patients. Five patients had bilateral tarsal coalition excision done concomitantly under the same anesthesia. Ten patients had both feet surgically treated but done at separate times, and both

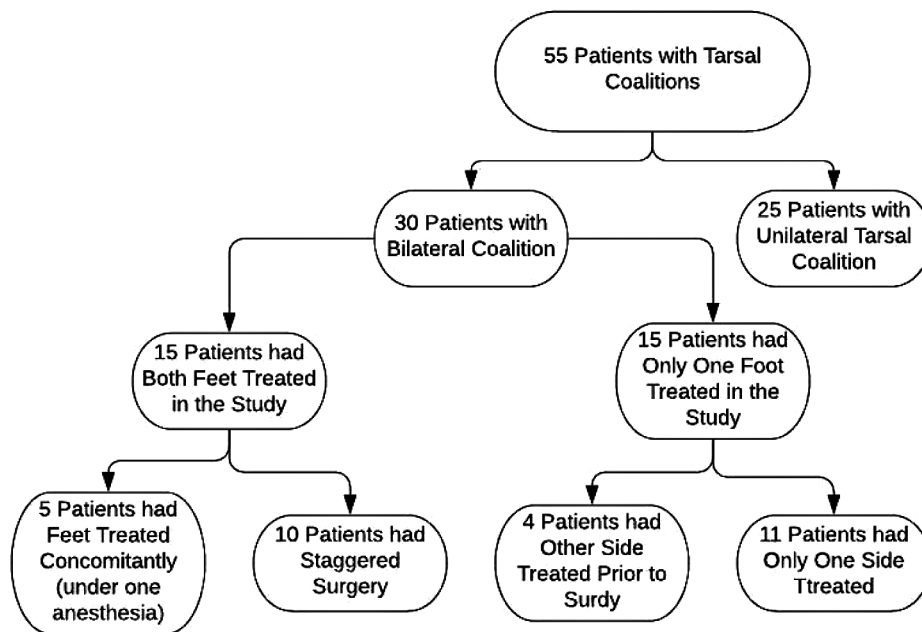


Figure 1. Schematic showing patient inclusion from the original prospective cohort.

feet were included in the study. Four patients had bilateral surgical coalition excision, but one foot was treated prior to the start of the study. Eleven patients had bilateral tarsal coalition, but only one foot was treated during the study; in these patients, one foot remained untreated during the study period.

Bilateral coalitions were compared to unilateral coalitions according to least (worst) mAOFAS score of the two feet. For patients with bilateral coalitions, we included both those that had bilateral excisions and those

with unilateral excisions. We found no difference in the preoperative mAOFAS scores and the postoperative mAOFAS score (Table 1). Similarly, we found no difference in UCLA activity scores and foot pain limiting activity pre- and postoperatively between the patients with bilateral and unilateral tarsal coalitions.

Patients with bilateral coalitions who had both coalitions excised showed no difference in modified AOFAS (mAOFAS) score, UCLA activity score, or activity limited by foot pain in this series as compared to those

Table 1. Comparison of patients with bilateral tarsal coalitions who had either or both coalitions excised compared to patients with unilateral tarsal coalition who had their coalition excised. The lowest (worst) mAOFAS score of the two feet was used for comparison. mAOFAS denotes modified American Orthopaedic Foot and Ankle Society score. UCLA denotes University of California Los Angeles activity score. SD denotes standard deviation

	Preop unilateral (n=23)	Preop bilateral (n=28)	Postop unilateral (n=25)	Postop bilateral (n=29)	p-value
mAOFAS score (mean \pm SD)	50.8 \pm 18.2	49.8 \pm 19.0	85.7 \pm 36.5	84.5 \pm 19.2	ns
UCLA activity score (mean \pm SD)	7.9	8.0	9.2	9.2	ns
Activity not limited by foot pain (freq. (%))	1/23 (4%)	0	18/25 (72%)	20/29 (69%)	ns

with bilateral coalitions who had only one side excised (Table 2). This was true when the bilaterally excised feet were compared with both the nonoperative and operative feet of the unilaterally-excised patients.

Among patients with bilateral tarsal coalitions who chose to have surgery on only one side, we compared preoperative to postoperative patient-based outcomes for the surgical side; we also compared the preoperative scores and the postoperative scores for the side that didn't have surgery. There was a significant difference in the mAOFAS before (mean 45.9 ± 10.7) and after (mean 78.9 ± 14.2) surgery on the side that had surgical excision of TC ($p < 0.05$). There was also improvement in the side that did not undergo surgery from before (mean 61.2 ± 10.5) to after (mean 86.1 ± 13.0) surgery on the contralateral side; this was not statistically significant.

For the 10 patients who underwent staggered bilateral coalition excision, we compared patient perceptions before and after the first surgery to those before and after the second surgery. Prior to the surgery, there was no difference in this group between their mean modified AOFAS scores of the side to undergo surgery (1st surgery 49.3, 2nd surgery 62.6, $p = 0.24$). At 6 months after surgery, there was also no difference between their mean modified AOFAS scores of the post-surgical side (1st surgery 73.7, 2nd surgery 86.2, $p = 0.22$). Similarly, at 24 months after surgery, there was no difference between the mean modified AOFAS scores after the first and second surgery (1st surgery 88.4, 2nd surgery 93.6, $p = 0.37$). There was no statistical difference at 24 months between

the first and second surgeries in foot pain limiting activity (after first surgery 4/9 had pain and after second 0/9 had pain, $p = 0.8$ fisher exact) but at 24 months after the second surgery, all patients (9/9) reported no pain limiting their activity in either foot.

Patients who underwent simultaneous bilateral coalition excision were compared to those who had staggered coalition excision (both in the study or had one foot done prior to study but filled out data on that foot during the study). Staggered patients had full recovery of their first foot prior to undergoing coalition excision on the contralateral foot. There was no difference in the mAOFAS scores of the patients who had surgery concomitantly (mean 91.8 ± 5.7) with those that had surgery staggered (mean 89.3 ± 11.0). Similarly, there was no difference in UCLA activity score and postoperative foot pain limiting their activity.

Discussion

Patients with bilateral tarsal coalitions offer a unique insight into the treatment and outcomes of all patients with coalitions. We focused particularly on the patient-based outcomes of patients with bilateral tarsal coalitions and compared them to both those with unilateral disease and to variations in the treatment of the bilateral process.

We found that patients with bilateral tarsal coalition have similar pain and patient-based outcomes at presentation as those with unilateral tarsal coalitions. Furthermore, they both respond in a similar fashion to surgical excision of the coalition. While perhaps not surprising,

Table 2. Comparison of patient-based outcomes in patients with bilateral tarsal coalition, where coalition is excised either bilaterally versus only unilaterally. mAOFAS denotes modified American Orthopaedic Foot and Ankle Society score. UCLA denotes University of California Los Angeles activity score. SD denotes standard deviation

	Unilateral excisions postop side (n=9/11)	Unilateral excised but this is nonop side	Bilateral both excised (n=18/19)	p-value
Modified AOFAS score (mean \pm SD)	78.9 ± 14.2	86.1 ± 13.0	90.0 ± 9.8	ns
UCLA activity score (mean \pm SD)	8.2 ± 2.4	Same as postop side	9.5 ± 1.6	ns
Activity not limited by foot pain (freq. (%))	6/9 (66%)	7/9 (78%)	32/36 feet in 15/18 patients (89% feet in 83% patients)	ns

the experience of the patient undergoing surgery for bilateral coalitions is unique from that of those with unilateral coalitions. If bilateral surgeries are done in a staggered fashion, then rehab postoperatively on a foot that has a coalition may conceivably present challenges. Additionally, learning to mobilize muscles previously made not functional by the coalition would in theory be made easier when the other foot moves in a normal fashion. So, the finding of similar results in the setting of bilateral disease process is very encouraging.

Some patients with bilateral tarsal coalitions choose to have surgery on only one side. We had previously found patients who chose to pursue surgery on only one side had poorer outcomes than those who chose to have bilateral surgery.⁷ However, in that study, we could not determine if it was the post-operative foot that was having more pain, or the untreated foot that was having more pain and influencing the poorer outcomes in the unilaterally treated group. The results of this study did not show a difference statistically in outcomes between patients treated for both of their tarsal coalitions compared to those treated for only one. Nonetheless, trends indicated that those patients who had only unilateral surgery for their bilateral tarsal coalitions had poorer outcomes in their postoperative foot than those who chose to have surgery on both sides. However, even those patients who had surgery unilaterally and reported relatively lower outcomes after surgery for their postoperative foot showed significant improvement in patient-based outcomes from their preoperative scores. Interestingly, in those patients with unilateral surgery for bilateral tarsal coalitions, the nonoperated foot showed similar improvement (although not significant) in outcomes scores after surgery for the contralateral foot.

For patients with bilateral tarsal coalitions treated with staggered surgical excision, we compared patient perceptions after the first excision to those after the second. This was inspired by the total joint literature suggesting markedly different patient satisfaction scores after the second surgery than after the first.⁸ We did not find a similar disparate response to staggered surgery

in tarsal coalition surgery. Patients reported similar outcomes after their first surgery to that which they reported after their second surgery.

Some patients had simultaneous bilateral tarsal coalition excision under one anesthesia. When compared to those patients undergoing staggered excision, we found no significant difference in outcome. This provides an interesting benchmark for patients who may want to consider bilateral surgery for this, as it may decrease the recovery time away from sports and activities.

The strength of this study was its prospective nature and the use of a standardized set of patient outcome measures. This study does have limitations. We did not achieve full 2-year follow-up data for all patients and reported data from earlier time points for some. Some of the potentially interesting subgroup analyses suffer from lack of power, and we were therefore limited in our ability to determine significance of results. We were limited to patients treated within the study timeframe. Unfortunately, some patients may have planned to return to have a contralateral foot surgery but hadn't yet done so.

In summary, patients undergoing surgery for bilateral tarsal coalition have similar patient-based outcomes to those with a unilateral process both before and after surgery. Some patients chose to have surgery on only one side, and they trend toward inferior outcomes in the postoperative foot from those who proceed with bilateral surgery. Finally, concomitant surgery for bilateral tarsal coalition has similar outcomes to those done in a staged fashion and can be considered for a more rapid return to activities.

Disclaimer

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References

1. Docquier PL, Maldaque P, Bouchard M. Tarsal coalition in paediatric patients. *Orthop Traumatol Surg Res.* 2019;105(1S):S123-S131.
2. Conway JJ, Cowell HR. Tarsal coalition: clinical significance and roentgenographic demonstration. *Radiology.* 1969;92(4):799-811.

3. Lawrence DA, Rolen MF, Haims AH, et al. Tarsal coalitions: radiographic, CT, and MR imaging findings. *HSS J*. 2014;10:153-166.
4. Bixby SD, Jarrett DY, Matheney T, et al. Unilateral subtalar coalition: contralateral sustentaculum tali morphology. *Radiology*. 2010;257(3):830-835.
5. Khoshbin A, Law PW, Caspi L, et al. Long-term functional outcomes of resected tarsal coalitions. *Foot Ankle Int*. 2013;34(10):1370-1375.
6. Luhmann SJ, Schoenecker PL. Symptomatic talocalcaneal coalition resection: indications and results. *J Pediatr Orthoped*. 1998;18(6):748-754.
7. Mahan ST, Spencer SA, Vezeridis PS, et al. Patient-reported outcomes of tarsal coalitions treated with surgical excision. *J Pediatr Orthoped*. 2015;35(6):583-588.
8. Lizaur-Utrilla A, Serna-Berna R, Vizcaya-Moreno MF, et al. Comparison of functional outcomes between the first and second knee in staged bilateral total knee arthroplasty with diverse intervals between stages. *J Arthroplast*. 2018;33(9):2863-2867.
9. Mahan ST, Miller PE, Kasser JR, et al. Prospective evaluation of tarsal coalition excision show significant improvements in pain and function. *J Pediatr Orthoped*. 2021;41(9):e828-e832.
10. Amstutz HC, Thomas BJ, Jinnah R, et al. Treatment of primary osteoarthritis of the hip. A comparison of total joint and surface replacement arthroplasty. *J Bone Joint Surg Am*. 1984;66(2):228-241.
11. Kitaoka HB, Alexander IJ, Adelaar RS, et al. Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. *Foot Ankle Int*. 1994;15(7):349-353.
12. Mahan ST, Prete VI, Spencer SA, et al. Subtalar coalitions: does the morphology of the subtalar joint involvement influence outcomes after coalition excision? *J Foot Ankle Surg*. 2017;56(4):797-801.