

Resection of calcaneonavicular coalition: Arthroscopic or open approach?

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Boris Corin¹, Pierre Laumonerie^{1,2}, Victor Zrounba¹, Tristan Langlais¹,
Jérôme Sales De Gauzy¹, and Franck Accadbled¹ 

Abstract

Purpose: Calcaneonavicular coalition accounts for more than half of all tarsal coalitions. Resection of calcaneonavicular coalition by an open approach is the standard treatment. Treatment of calcaneonavicular coalition by an arthroscopic approach appears promising. The objective of our study was to compare the clinical outcomes of calcaneonavicular coalition resection by open approach versus arthroscopic approach.

Methods: A retrospective cohort study was conducted to evaluate 127 patients who underwent a resection of calcaneonavicular coalition from 2009 to 2017. Patients were divided into two groups according to whether an arthroscopic approach or an open approach was used. Demographics, operative parameters, and clinical outcomes (foot and ankle ability measure score, subjective score, and global ankle estimation) were assessed.

Results: Arthroscopic approach was used for 81 patients and open approach for 46 patients. Treatment with arthroscopic approach resulted in a shorter hospital stay (2.6 ± 0.6 days vs 3.0 ± 0.7 ; $p=0.02$) and a longer operative time (24.5 ± 8.1 min vs 20.5 ± 4.2 ; $p < 0.01$) than with open approach. The foot and ankle ability measure sports subscale scored significantly higher in the arthroscopic approach group (90.9 vs 77.3; $p=0.003$). Revision rate was significantly higher in the arthroscopic approach group (12 (15%)) versus the open approach group (1 (2%)) ($p=0.024$). Persistent symptoms ($n=12$) were the main reason for revision.

Conclusions: Arthroscopic treatment of calcaneonavicular coalition is associated with a higher revision rate than the open approach.

Level of evidence: Level III—retrospective comparative study.

Keywords: Tarsal coalition, arthroscopy, pediatrics, sports medicine, ankle pain, foot, treatment, recurrence

Introduction

Calcaneonavicular coalition (CC) accounts for 53% of all tarsal coalitions.¹ Symptoms vary in intensity from simple discomfort (e.g. mechanical pain, repeated ankle sprains) during sports activities to daily and/or painful limping. Altered quality of life can also be caused by the development of joint stiffness, foot deformities, and in the long run, osteoarthritis of the foot and ankle.^{1,2} The first line of treatment is usually non-operative and combines non-steroidal anti-inflammatory drugs with rest from sports, immobilization, orthopedic insoles, and local corticosteroid injection.³ Surgical resection is indicated when symptoms persist for more than 6 months despite this treatment.^{4,5}

The standard procedure for CC resection is the open anterolateral approach (OA) known as Ollier's.⁵ The procedure consists of resecting the coalition, supplementing

with muscle or fat interposition to prevent recurrence.^{6–8} The long-term results of OA procedures are satisfactory.⁹ Khoshbin et al. noted American Orthopedic Foot and Ankle Score (AOFAS), American Academy of Orthopaedic Surgeons (AAOS), and Foot Function Index (FFI) scores of 83.6, 76.8, and 19.5, respectively, in 24 patients with a mean follow-up of 15 years.⁹ However,

¹Department of Orthopaedics, Hôpital des Enfants, CHU de Toulouse, France

²Department of Orthopaedics, Hôpital Pellegrin, Bordeaux, France

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Corresponding Author:

Franck Accadbled, Orthopédie Traumatologie, Hôpital des Enfants, 330 avenue de Grande Bretagne, 31059 Toulouse cedex 9, France.
Email: faccadbled@gmail.com



Table 1. Comparison of baseline demographics and clinical parameters.

	Overall <i>n</i> = 127	Arthroscopy <i>n</i> = 81	Open <i>n</i> = 46	<i>p</i> value
Gender, <i>n</i> (%)				0.737
Male	41 (32%)	27 (33%)	14 (30%)	
Female	86 (68%)	54 (67%)	32 (70%)	
Age at the time of surgery	13.0 (\pm 1.7)	13.2 (\pm 1.6)	12.7 (\pm 1.7)	0.185
Side, <i>n</i> (%)				0.699
Right	66 (52%)	47 (58%)	19 (41%)	
Left	61 (48%)	34 (42%)	27 (59%)	
Follow-up time, <i>months</i>	67.1 (\pm 27)	75.6 (\pm 25)	57.4 (\pm 25)	0.003
Preoperative pain, <i>n</i> (%)				0.187
Yes	124 (98%)	78 (96%)	46 (100%)	
No	3 (2%)	3 (4%)	0	
Recurrent preoperative sprains, <i>n</i> (%)				0.085
Yes	57 (45%)	41 (51%)	16 (35%)	
No	70 (55%)	40 (49%)	30 (65%)	
Preoperative incapacity to run, <i>n</i> (%)				0.010
Yes	84 (66%)	47 (58%)	37 (80%)	
No	43 (34%)	34 (42%)	9 (20%)	

Bold denotes statistical significance.

the complication rate of open CC resections is 13%, wound dehiscence being the main complication according to Masquijo et al.⁷

Several authors have proposed arthroscopic resection to reduce the morbidity of the procedure, and to accelerate recovery.^{10–13} A preliminary study by Bourlez et al.¹⁴ reported a mean short-term AOFAS score of 89.1 in 10 patients with AA. Although the results of AA seem promising, there has been no comparison of the results of CC resection by AA versus OA in the literature.^{10–12,14}

The objective of our study was to compare the clinical outcomes of CC resection by OA and by AA. The hypothesis was that AA resection of CC provides superior outcomes compared to OA.

Materials and methods

Patient population

The institutional review board approved (# 15-1219) this retrospective review of patients aged 8–18 years who underwent surgery for CC between January 2009 and December 2017 in our tertiary care university hospital. A total of 238 patients with tarsal coalition underwent surgical resection, of which 111 were excluded because the coalition did not involve the calcaneonavicular space. Finally, 127 patients with isolated unilateral or bilateral CC and failed non-operative management were included. Two surgeons performed the AA procedures, whereas several different surgeons performed the OA procedures. A total of 81 patients underwent surgery by AA and 46 patients underwent surgery by OA. Patient demographic data are summarized in Table 1. Minimum clinical and

radiographic follow-up was 24 months. Mean follow-up of the entire cohort was 67.1 months (\pm 27), that is, 75.6 months (\pm 25) in the AA group and 57.4 months (\pm 25) in the OA group ($p=0.003$).

Data collection

Outpatient clinic (preoperative and follow-up), hospital stay, and surgical procedure (AA, OA, operative time) reports, as well as anteroposterior (AP)/lateral and oblique view radiographs, and computed tomography (CT) scans were reviewed by an orthopedic surgeon (CB). Foot and ankle ability measure (FAAM) functional scores (activities of daily living (FAAM-*adl*) and sports (FAAM-*s*) subscales) and subjective measures, as well as a global assessment of the ankle were recorded during a dedicated telephone interview.^{15,16} The clinical outcomes (i.e. at the latest clinical follow-up), as well as complications and causes of revision were also recorded.

Surgical technique

Regardless of the technique used (i.e. AA or OA), the patient was placed in a supine position, under general anesthesia. A tourniquet was placed above the knee and a bolster under the ipsilateral buttock to expose the dorsolateral aspect of the foot.

Open approach

The surgical technique used for the OA group was CC resection by a dorsolateral oblique approach of the lateral projection of the talonavicular joint and along the anterior

Table 2. Description of the functional outcome after resection of calcaneonavicular synostosis with the arthroscopic and the open approach.

	Overall n = 127	Arthroscopy n = 81	Open n = 46	p value
FAAM score, n (%)				
Activities of daily living	92.4% (\pm 13.0)	94.5% (\pm 10.2)	90.0% (\pm 15.4)	0.151
Sports	84.5% (\pm 19.8)	90.9% (\pm 13.9)	77.3% (\pm 22.8)	0.003
Subjective score, n (%)				
Daily	89.3% (\pm 15.9)	91.8% (\pm 15.5)	86.0% (\pm 15.9)	0.138
Sports	78.1% (\pm 27.3)	80.7% (\pm 29.3)	74.9% (\pm 24.1)	0.365
Overall estimate, n (%)				
Normal	44 (58%)	28 (67%)	16 (47%)	0.085
Almost normal	20 (26%)	9 (21%)	11 (32%)	0.282
Below normal	8 (10%)	2 (5%)	6 (18%)	0.069
Well below normal	4 (5%)	3 (7%)	1 (3%)	0.415

FAAM: foot and ankle ability measure.
Bold denotes statistical significance.

process of the calcaneus (i.e. the Ollier approach).⁵ The extensor digitorum brevis muscle was incised and elevated and CC resection was performed using a narrow osteotome and a rongeur. A flap of extensor digitorum brevis muscle was created and interposed.

Arthroscopic approach

CC resection by AA was performed according to the technique by Knörr et al.¹⁰ The arthroscopic portal was placed dorsally to the *Gissane* angle at the posterior aspect of the anterior process of the calcaneus. The instrument portal was anterior and distal to the anterior process of the calcaneus, and lateral to the extensor digitorum longus tendon. Correct placement of the portals was checked using oblique image intensifier view. The extensor digitorum brevis muscle was detached with a shaver, then the CC was identified and resected using an arthroscopic burr and curette. The amount of resected tissue was checked both arthroscopically and radioscopically. No interposition was performed.

In both AA and OA techniques, the aim was to create a complete gap of 10 mm.

Postoperative care

Regardless of the technique used, patients were immobilized in a below-knee splint, non-weight-bearing for 8–10 days. Weight-bearing and active mobilization were encouraged thereafter.

Statistical analysis

Descriptive statistics (mean with standard deviation for continuous variables and frequencies with proportions for categorical data) were used to summarize recorded

variables. Covariates were compared using Wilcoxon rank-sum and Pearson's chi-square tests. *P*-values less than 0.05 were considered statistically significant. A statistical analysis was carried out using R (version 3.3.2, R Core Team 2013. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria).

Results

The duration of the surgical procedure was significantly longer in the AA (24.5 min (\pm 8.1)) versus the OA (20.5 min (\pm 4.2)) groups ($p < 0.001$). Mean hospital stay was significantly shorter in the AA (i.e. 2.6 days (\pm 0.8)) versus the OA (i.e. 3.0 days (\pm 0.7)) groups ($p = 0.02$).

The FAAM-*s* score (90.9 vs 77.3; $p = 0.003$) was significantly higher in the AA group. The FAAM-*adl* score ($p = 0.151$), subjective measure *daily activity* ($p = 0.138$) and *sports* ($p = 0.365$) scores did not differ significantly between the groups. There was no significant difference in the overall assessment of ankle function between the groups (Table 2).

At latest follow-up, the rate of persistent symptoms (46 (56.8%) vs 17 (37.0%); $p = 0.032$) and revisions (12 (14.8%) vs 1 (2.2%); $p = 0.024$) were significantly higher in the AA group than in the OA group (Table 3). Persistent symptoms ($n = 10$ CCs by AA and $n = 1$ CC by OA) and surgical site infection ($n = 2$ CCs by AA) were the two reasons for revision by OA (7) and AA (6). Revision showed recurrent CC in four of the 12 AA-group patients and in the only OA-group patient.

Discussion

Revision rate related to the persistence of symptoms was higher after AA of CC than OA. We confirmed

Table 3. Clinical outcome for resection of calcaneonavicular synostosis after the arthroscopic and the open procedure.

	Overall <i>n</i> = 127	Arthroscopy <i>n</i> = 81	Open <i>n</i> = 46	<i>p</i> value
Clinical outcomes, <i>n</i> (%)				
Persistent symptoms	63 (50%)	46 (57%)	17 (37%)	0.032
Pain				
Mechanical	30 (24%)	22 (27%)	8 (17%)	0.213
Neuropathic	12 (9%)	7 (9%)	5 (11%)	0.680
Incomplete sports recovery	47 (37.0%)	35 (43.2%)	12 (26.1%)	0.055
Wound dehiscence	6 (5%)	4 (5%)	2 (4%)	0.880
Infection	2 (2%)	2 (2%)	0	0.283
Peroneal tendonitis	2 (2%)	2 (2%)	0	0.283
Hypoesthesia of the hallux	1 (1%)	1 (1%)	0	0.449
Revision surgery, <i>n</i> (%)				0.024
Yes	(10%)	12 (15%)	1 (2%)	
No	114 (90%)	69 (85%)	45 (98%)	

Bold denotes statistical significance.

the satisfactory functional results obtained by operative treatment of CC, regardless of the approach (Table 3).¹⁰ Masquijo et al. reported a mean AOFAS score of 98/100 at 2.9 years with CC resection by OA along with fat interposition (*n* = 23).⁷ Khoshbin et al.⁹ also obtained satisfactory long-term AAOS Foot and Ankle Core Scale (FACS) (83.6), AAOS Shoe Comfort Scale (SCS) (76.8), and *FFI* (19.5) scores (i.e. > 15 years of follow-up) with CC resection by OA (*n* = 19). This series showed that the FAAM-*s* score for the AA group was significantly higher than for the OA group (*p* < 0.01). The other functional scores (FAAM score, subjective score, and global ankle estimate) were also higher in the population treated by AA, although without reaching statistical significance.

Overall revision rate was 10.2%. Masquijo et al.⁷ also noted a 14% revision rate after CC resection by OA along with fat interposition. However, the revision rate (12 (14.8%)) was significantly higher in the group treated by AA for CC. Persistence of symptoms was the main reason for revision (*n* = 11, 84.6%). Reformation of the coalition was confirmed in five patients and may be related to the absence of muscle or fat interposition in patients treated by AA, even though arthroscopy allows a very clear intraoperative view of the created defect, including in depth to the plantar fat and muscle.

The mean duration of CC resections by AA (24.5 min) was significantly longer than by OA (20.5 min) (*p* < 0.01). However, we considered that this average difference in operative time of less than 5 min, may only have a mild impact on the clinical outcome. Hospital stay was significantly shorter for patients treated by AA (2.6 days vs 3.0; *p* = 0.02). AA allowed minimally invasive treatment of CC, notably with a reduction in the size of skin incisions and in soft tissue detachment. We hypothesized that AA would facilitate ambulatory management of patients with CC

through the reduction of pain and the needs for wound care postoperatively. However, the relatively large inclusion time of the study (2009–2017) also accounts for a general trend toward day surgery, regardless of the operative technique selected.

The limitations of this study were related to its retrospective nature, and the lack of long-term follow-up. Retrospective data collection inevitably led to loss of information and induced biases. The relatively small number of patients, especially in the OA group, limited the statistical power of univariate comparisons. In addition, the OA group was significantly more unfit for sports preoperatively. Therefore, we could not exclude the possibility that the difference in FAAM-*s* score could be related to the patients' participation in sports prior to surgery, rather than to the type of approach (OA or AA). However, the functional scores (i.e. FAAM-*s* and FAAM-*adl*) were not measured preoperatively. Finally, the mean follow-up time was significantly greater in the AA group than in the OA group. This could have influenced the functional scores as well as the rates of complications and/or revisions.

Conclusion

AA was associated with higher revision rate related to the persistence of symptoms than OA for resection of CC. A prospective randomized study would determine the independent effect of AA on long-term functional outcomes in patients with CC.

Author contributions

Corin Boris contributed to data acquisition, data analysis and interpretation, and manuscript writing. Laumonerie Pierre contributed to data analysis and interpretation, critical revisions, manuscript writing, manuscript review, and statistical analysis.

Zrounba Victor contributed to data acquisition. Langlais Tristan contributed to critical revisions and manuscript review. Sales de Gauzy Jérôme contributed to critical revisions, manuscript review, administration, and study supervision. Accadbled Franck contributed to study design, data analysis and interpretation, critical revisions, manuscript review, administration, technical and material support, and study supervision.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

This research involved strictly human participants. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Institutional Review Board approval: # 15-1219.

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Informed consent

Written informed consent was obtained in each case from both the patient and the parents.

ORCID iD

Accadbled Franck  <https://orcid.org/0000-0001-5366-3885>

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