Anterior tarsectomy long-term results in adult pes cavus

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Accepted: 31 March 2009

KEYWORDS
Pes cavus; Anterior tarsectomy; Midfoot osteotomies

Summary
Purpose of the study: Anterior tarsectomy for pes cavus in adults is designed to relieve pain and correct the deformity. The present study reports radiological and clinical results with anterior tarsectomy in 39 cases of pes cavus.
Material and methods: The study concerned 39 cavus feet in 33 patients (22 males, 11 females; mean age: 31 years, range 16—49 years). Clinical outcome was assessed in terms of pain, function and motion, using the AOFAS classification. Radiological assessment (anteroposterior and lateral stress X-ray, views with Méary superficial wire-marking) measured the Djian angle, talometatarsal alignment, talar slope, calcaneal slope, calcaneal valgus, and osteoarthritis stage in adjacent joints.
Results: Mean follow-up was 9.8 years (range, 1—25). Mean AOFAS score at follow-up was 69.2/100 points (range, 14—100). Pain decreased considerably in 75% of cases, and 68% of patients recovered normal activity. The foot was aligned correctly in 67% of cases. At last follow-up, pes cavus remained undercorrected in 80% of feet, but mean Djian angle had improved from 100° to 111.3°. Calcaneal valgus improved from 30.8° to 24.8° and the podoscopic footprint was normal in 51% of feet. In 74% of feet, adjacent joints presented progressive osteoarthritic degeneration. Subjectively, 70% of patients were very satisfied or satisfied with minor reservations. Objective outcome was excellent or good in 66% of feet.
Discussion and conclusion: Outcome in terms of function, motion, complications and satisfaction was good, although pain relief results were poor. Anterior tarsectomy is able to correct initial pes cavus deformity and compensate anomalies of the hindfoot, but its correction capacity is limited, and its efficacy in case of clawfoot is poor. Anterior tarsectomy spares the adjacent Chopart complex and Lisfranc joints while inducing hypermobility, and leads to arthritis in 74% of cases. Better results are obtained in cases of reestablishment of the Méary-Tomeno line and of hindfoot valgus, as well as in cases of correction of equinus and clawfoot deformities. Worse results are observed in case of neurological evolutive disease or insufficient correction of the preceding deformities.

Level of evidence: Level IV. Therapeutic Study.

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Introduction

Pes cavus is one of the most frequent static disorders of the forefoot [1–4], generally remaining asymptomatic. In case of associated pain, adapted medical and orthopedic management is often effective. The role of surgery for decompensated adult pes cavus is thus limited.

In response to the complexity and anatomoclinical variety of the pathology, numerous surgical techniques have been developed, with dorsal-based wedge osteotomy as the reference procedure in adults. The principle underlying anterior tarsectomy is to correct forefoot plantar flexion by a dorsal cuneiform bone resection centered on the cuneonavicular joint space.

The technique, first described by Cole [5], was popularized in France in 1967 by Méary [6], who went on to publish his results 10 years later. Since then, however, there have been few reports of long-term outcome.

The present study sought to analyze long-term results with this technique. Patients undergoing anterior tarsectomy in the Lille (France) teaching hospital between 1955 and 2000 (33 patients; 39 tarsectomies) were reviewed, with a mean 10 years’ follow-up.

Material and methods

Series

This was a retrospective study of all patients operated on by Cole-Méary anterior tarsectomy [5,6] in the Lille teaching hospital’s orthopedic department between 1955 and 2000: i.e., 45 tarsectomies in 38 patients.

After exclusion of two deceased patients, one lost to FU, and two in whom clinical examination was not feasible (one amputated for vascular reasons, and one case of cerebral palsy), 33 patients were reviewed, for 39 anterior tarsectomies.

Mean age at surgery was 31 years (range, 16–49 years); 22 male, 11 female. Fifteen patients (45%) were operated on the left side, 12 (36%) on the right, and six (18%) bilaterally. Fourteen did physical work; 19 were sedentary workers; only five played sports preoperatively.

Etiology

Etiology was neurological in 19 patients (20 feet: 51%): six cases of poliomyelitis, four of Charcot Marie Tooth, three of Friedreich ataxia, two of hemiplegia, one perinatal encephalopathy, one degenerative neuropathy, and two unknown. Ten patients presented with idiopathic pes cavus (14 feet: 36%). Two cases were secondary to varus equine clubfoot, and one was secondary to trauma. No etiological information was available for one patient, operated bilaterally.

Anatomoclinical type

Thirty-two of the 39 pedes cavi (82%) were of mixed type (anterior + posterior) and seven (18%) purely anterior. Plantar flexion predominantly involved the 1st metatarsal in 25 cases (64% anteromedial pedes cavi), affecting all the metatarsals in nine (23% direct pedes cavi). In five cases (13%), typology could not be determined.

Most cases, then, were of complex deformity: 12 of hindfoot equinus (30%), 23 of hindfoot varus (59%), 16 of irreducible forefoot pronation (41%), and 21 of forefoot adduction (54%), with four feet associating all these morphological abnormalities.

Anterior surgery was performed on 12 feet, associating calcaneal tendon lengthening, dual subtalar/mediotarsal arthrodesis, Jones transfer (hallux extensor transfer onto 1st metatarsal neck), Hibbs transfer (anterior tibial tendon transfer onto 3rd cuneiform), clawfoot correction, metatarsal osteotomy or metatarsal head resection.

Symptoms

Pain was the main reason for consultation (85% of cases), usually implicating the 1st metatarsal head (67%), but sometimes occurring under the heel (9%) or as footwear conflict (14%). Twenty-eight patients (72%) also presented with impaired gait, and 24 (61%) with footwear discomfort.

Preoperative radiography

The mean preoperative Djian angle was 100° (85–116°), and the mean preoperative Tomeno angle 23° (8°–45°). Mean preoperative calcaneal slope was 31° (15°–50°) (Fig. 1). The Ménéry-line break corresponding to the summit of the deformity was at the level of the talus in one case (2.6%), the Chopart joint space in seven (18%), the navicular bone in 13 (33%), the cuneonavicular joint in three (7.7%), the 1st cuneiform in six (15.4%), and the Lisfranc joint space in two (5.2%). In 56% of cases, correction was performed at the deformity summit. In seven cases, the summit could not be precisely located, due either to the size of the deformity or to poor X-ray quality.

Surgical technique

All the patients included in the study underwent anterior tarsectomy using the technique described by Cole [5] and Méary [6]. The aim was to correct the deformity by dissecting a hexahedron, wider superiorly and mediually than inferiorly and laterally, in the anterior tarsus, taking care to restore talometatarsal alignment on lateral stress X-ray (Fig. 2).

The patient was installed in dorsal decubitus, with a pad under the ipsilateral buttock and a tourniquet at the root of the lower limb. The surgeon stood laterally to the operated foot. A dual longitudinal dorsal approach was systematically adopted.

Figure 1 Preoperative planning.
The 6–8 cm medial incision followed the 2nd metatarsal axis and was centered on the 2nd cuneiform. The extensor hallucis longus and anterior tibial tendons were laid outwards, protecting the vasculonervous tissue and giving access to the medial part of the tarsus. The lateral incision was centered slightly dorsally on the cuboid bone. The fibularis brevis tendon was laid towards the sole, and the extensor digitorum brevis laid upwardly. The two incisions were joined, passing under the extensor digitorum brevis with a raspatory, enabling the whole superior tarsal face to be controlled and the cuneonavicular joint space to be located. Osteotomy was guided by two K-wires introduced medially on either side of the cuneonavicular joint, converging in the cuboid bone. The osteotomy trajectory was checked on medial-to-lateral, superior-to-inferior peroperative X-ray (Fig. 3).

The 5th metatarsal styloid and calcaneocuboid joint space were conserved, and the osteotome left in place. Turning next to the medial incision, posterior osteotomy was performed transversally on the middle part of the dorsal side of the navicular bone in a frontal plane at an angle of 10°–15° down and back with respect to the plane of the leg. This section plane joined the section begun externally. Anterior resection followed this posterior reference plane, the extent of the resection depending on the size of the correction to be made.

Closure was temporarily maintained, with pronosupination correction if necessary. Talometatarsal alignment was checked on lateral X-ray. Osteosynthesis was achieved using one medial and one lateral staple.

The procedure was sometimes associated to plantar aponeurectomy (33% of cases), calcaneal tendon lengthening (5%) or clawfoot correction (5%). There was no bone surgery to the hindfoot. Mean hospital stay was 10 days. Non-weight-bearing cast immobilization was systematic, for a mean nine weeks, followed by rehabilitation in all cases.

Assessment methods

Clinical results were evaluated by AOFAS criteria and Kitaoka midfoot-scale score [8]. Clinical examination further assessed ankle and foot mobility, hindfoot stability and podoscopic plantar footprint.

At follow-up, stress X-rays were taken for each operated foot. The Djian and Annonier angles [9], the angle of the Méary-line break formed by the intersection of the talar and 1st metatarsal axes, and the talar and calcaneal slopes were measured from the lateral views; forefoot adduction and metatarsal spread were assessed from the anteroposterior views; and calcaneal valgus was assessed from the Méary views by the Djian quadrilateral method [10]. Patients whose preoperative X-rays could not be analyzed were included in clinical follow-up but not in the radiographic study.

Finally, the Morrey-Wiedman classification [11], initially intended for the tibiotalar joint, was used to assess arthritis status in each adjacent joint space on either side of the arthrodesis, as stage 0 (normal joint), stage I (moderate joint space narrowing and osteophytosis), stage II (distinct joint space narrowing, subchondral condensation and edge sclerosis), or stage III (severe arthritis).

Statistical analysis was by Chi² test for comparison of qualitative variables, paired *t*-test for comparison of quantitative variables, non-paired *t*-test for comparison of qualitative and quantitative variables and correlation tests for non-matched pairs of quantitative variables. The significance threshold was set at *p* < 0.05.

Results

Mean follow-up was 9.8 years (range: 1–25 years).

Postoperative results

There were five peroperative complications (12%): one cuboid fracture, one complete navicular exeresis, two calcaneocuboid staples, and one talonavicular staple. However, all these patients showed satisfactory AOFAS scores (mean, 76.8) on follow-up (Fig. 4).

There were 12 postoperative complications (31%): one cuneonavicular malunion (consolidated by bone graft), six cutaneous complications, one sepsis and four reflex sympathetic dystrophy syndromes.

Seven patients were reoperated for tarsectomy failure. The above-mentioned malunion was consolidated by autograft. Calcaneal tendon lengthening was performed in one case of persistent equine foot. One patient, initially operated on for anteromedial neurologic pes cavus, was pain-free for nearly seven years then developed a painful corn facing the 1st metatarsal head, resolved by osteotomy to raise the 1st metatarsal.
Four other patients required repeat mediotarsal tarsectomy using the Imhauser technique [12]:

- in two cases, cavus hypercorrection was associated with residual forefoot pronation, causing metatarsalgia under the 1st metatarsal head;
- one particularly severe neurologic pes cavus was only partially corrected by the anterior tarsectomy. Given persistent painful corns, the only resort was to mediotarsal tarsectomy;
- one patient, with bilateral pes cavus secondary to Friedreich ataxia, operated bilaterally with a good anatomic result, showed recurrence in one foot, with considerable aggravation in the form of severe equine varus; mediotarsal tarsectomy was required six months after the initial operation.

Clinical results

Mean final AOFAS score was 69.2 out of 100 points (range: 14—100).

Pain

Mean pain score was 28.2/40, with 11 patients totally pain-free (28.2%), and 18 (46.2%) with mild, six (15.4%) with moderate, and four (10.2%) with severe pain. Sixty percent of cases of residual pain involved metatarsalgia; the other causes were more difficult to identify, and could be due to arthritis or to the osteotomy or osteosynthesis material.

Function

The mean functional score was 29/45, covering activity, footwear use, walking distance and surface quality, and gait. The mean activity score was 6.5/10, 24.2% of patients having recovered normal activity, 39.4% experiencing difficulty in leisure activity, and 27.3% experiencing difficulty in everyday activity. For three patients (9%) everyday activity and autonomy were greatly impaired.

The footwear component averaged 4/5 points, 64% of patients wearing normal footwear, 28% using customized insoles, and 8% orthopedic footwear.

The mean walking distance score was 8.3/10. Twenty-five patients (76%) could walk unlimited distances, three (9%) without much limitation, two (6%) less than 300 m, and three (9%) less than 100 m. Only three patients could walk confidently on rough ground. Gait quality scored a mean 7.4/10.

Radiographic results

Radiopodometry (Fig. 5)

Six of the 39 operated feet (17%) were podometrically normal (120—130°), and one was hypercorrected, with a flat morphotype (> 130°). Twenty-nine feet (80.5%) showed residual pes cavus (< 120°: 12 anterior and 17 mixed).

Table 1 Alignment of forefoot and hindfoot.

<table>
<thead>
<tr>
<th>Alignment</th>
<th>Hindfoot</th>
<th>Forefoot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>25 cases (64.1%)</td>
<td>26 cases (33.3%)</td>
</tr>
<tr>
<td>Moderate</td>
<td>10 cases (25.6%)</td>
<td>10 cases (25.6%)</td>
</tr>
<tr>
<td>Poor</td>
<td>4 cases (10.2%)</td>
<td>3 cases (7.6%)</td>
</tr>
<tr>
<td>AOFAS score</td>
<td>7.8/10</td>
<td>12/15</td>
</tr>
</tbody>
</table>

Table 2 Mobility of forefoot and hindfoot.

<table>
<thead>
<tr>
<th>Hindfoot mobility</th>
<th>Normal or slightly reduced</th>
<th>Slightly limited</th>
<th>Very limited</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 cases (33%)</td>
<td>17 cases (43%)</td>
<td>9 cases (23%)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Forefoot mobility</th>
<th>Normal or slightly reduced</th>
<th>Slightly limited</th>
<th>Very limited</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 cases (33%)</td>
<td>20 cases (51%)</td>
<td>3 cases (7.7%)</td>
<td></td>
</tr>
</tbody>
</table>

Points: at follow-up, 19 patients (58 %) showed normal gait, 11 (30%) a slight limp, and three (9%) a pronounced limp.

Forefoot alignment

Forefoot alignment scored a mean 12 points out of 15. It was good in 26 feet (66.7%), with a reduction defect in 10 (25.6%) and considerable residual deformity in three (7.7%). Twenty-two patients had resumed working activity at follow-up, but only three had taken up sport again.

Ankle mobility

Ankle mobility exceeded 30° in 20 cases (51.3%), was between 15° and 30° in 14 (35.9%), and was less than 15° in five (12.8%). Seven of the 12 primary equine feet were successfully reduced, with 10° residual equinus in five cases. Table 1 shows AOFAS fore- and hindfoot alignment scores, and Table 2 the fore- and hindfoot mobility values (not included in the AOFAS form).

Podoscopic examination found 20 normal footprints (51%), 15 residual pedes cavus (38.5%), including nine type-1 and six type-2, and one flatfoot. In three cases, the examination could not be performed.
Measurement could not be made in three cases, due to extensive arthritic remodeling.

Mean Djian angle increased from $100^\circ$ to $111.3^\circ$ ($92^\circ$–134$^\circ$) postoperatively, and the mean Tomeno angle showed $14^\circ$ correction, decreasing from $23^\circ$ to $9^\circ$ (range: $-6^\circ$ to $+35^\circ$).

Mean calcaneal slope fell from $30.8^\circ$ to $24.8^\circ$ ($9^\circ$–38$^\circ$).

Hindfoot position was assessed on Méary view, except in five cases in which the examination could not be performed. The hindfoot axis was considered normal when the tibial axis cut the rectilinear below-heel weight-bearing plane at the point between its medial third and lateral two-thirds. In 23 cases (67.6%) it was normal; eight (23.5%) showed residual varus; there were three cases of valgus deviation.

Osteoarthritis

In eight cases, the degree of deformity precluded any X-ray assessment of arthritis. In the remaining 31 cases, arthritis was assessed on the Morrey-Wiedman classification [11], as shown in Fig. 6.

At follow-up, 74.2% of feet showed radiographic signs of arthritis. A single case of incipient talocrural arthritis was observed. The subtalar joint was frequently (18 cases) but moderately (grades 1 and 2) implicated. Mediotarsal joint involvement was likewise frequent (17 cases), but often more severe (grades 2 and 3). The Lisfranc joint space was affected in 12 cases.

Results analysis

There was no significant relationship between functional, objective and subjective results on the one hand and age at surgery on the other. Nor did age at onset affect results. Surgical history did not affect results adversely, nor preoperative medical management beneficially.

Etiology

Final mean AOFAS score in neurologic pes cavus was 62/100, versus 76.3 in idiopathic cases ($p = 0.048$): etiology thus influenced outcome. The degree of correction also depended on etiology, with less correction in neurologic than idiopathic pes cavus ($p = 0.05$) (Table 3).

Preoperative mobility

Preoperative ankle and hindfoot joint flexibility enhanced correction capacity. Djian angle, Tomeno angle and calcaneal slope correction was better when preoperative hindfoot mobility was normal ($p = 0.03$, 0.01 and 0.04, respectively), and the correlations with preoperative ankle mobility were even more significant ($p = 0.0007$, 0.001 and 0.04, respectively).

Osteoarthritis

Osteoarthritis had a significant impact on final AOFAS score ($p = 0.03$), patients free of arthritis scoring a mean 86 points, versus 66.7 for those showing signs of arthritis on control X-ray. Mean pain scores likewise were 36.2 vs 29.5, respectively ($p = 0.018$). Arthritis diminished patients’ activity and walking distance ($p = 0.05$).

Radiopodometry

Only the postoperative Tomeno angle impacted final AOFAS score final ($p = 0.03$), influencing gait ($p = 0.01$), footwear use ($p = 0.08$) and activity ($p = 0.02$). The Djian angle only influenced activity ($p = 0.02$). Evidence of clawfoot at follow-up correlated with wide Djian and Tomeno angles. Twenty-three hindfoot alignments (67.6%) were good at follow-up, surgery seeming to have corrected the hindfoot varus. The mean AOFAS score in case of good hindfoot alignment was 75, versus 33.7 for malalignment: i.e., hindfoot alignment correlated strongly with final score ($p = 0.0003$). No significant relationship emerged between hindfoot alignment and arthritis.

Discussion

The first publications concerning anterior tarsectomy, by Saunders [13] in 1935, Cole [5] in 1940 and Brockway [14] in 1940, comprised some hundred patients. If series have been smaller in more recent reports, this is probably due to the eradication of pathologies such as anterior poliomyelitis and to tighter criteria. The number of patients we have operated on over a period of 45 years may not seem considerable, but corresponds to that found in most recent studies of pes cavus surgery [7,15–19]. The most recent previous report, published in 2004, concerned a series of 11 patients at 23 months’ FU [20].

The mean follow-up for the present series was nearly 10 years (range: 1–25), with 21 tarsectomies having more than 10 years’ FU. This is thus one of the longest follow-ups in the literature, allowing the incidence of foot-joint osteoarthritis following tarsectomy to be evaluated.

### Table 3  Angular correction according to etiology.

<table>
<thead>
<tr>
<th>Angular correction</th>
<th>Djian</th>
<th>Tomeno</th>
<th>Calcaneal slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean correction</td>
<td>$11.3^\circ$ (7–19)</td>
<td>$14^\circ$ (10–27)</td>
<td>$6^\circ$ (4–12)</td>
</tr>
<tr>
<td>Neurologic pes cavus</td>
<td>$9^\circ$ (7–14)</td>
<td>$11^\circ$ (10–13)</td>
<td>$5.4^\circ$ (4–8)</td>
</tr>
<tr>
<td>Idiopathic pes cavus</td>
<td>$12.3^\circ$ (9–19)</td>
<td>$17.7^\circ$ (12–27)</td>
<td>$8.3^\circ$ (5–12)</td>
</tr>
</tbody>
</table>
Etiology

Neurologic pes cavus predominated (56.4%) in the present as in previous series: Melka et al. [21] reported 27 neurologic etiologies for 45 pedes cavati, and Méary [7] and Leal [17] had rates of around 50% in their respective series. This confirms that idiopathic pes cavus is actually rare.

We demonstrated that etiology influences outcome, neurologic pes cavus being associated with lower AOFAS scores than in idiopathic cases. This difference may be due to a greater complexity of deformity in neurologic pes cavus, 85% of which in the present series presented an anteromedial anatomicclinical aspect. Neurologic pathology may also affect outcome by inducing either recurrence or functional disorder [22]. Neurological assessment, comprising (non-exhaustively) examination by a neurologist and neurophysiological testing, is indispensable. Lesion stability also needs to be checked by repeated examination [23].

Prior treatment

Classic management programs indicate surgery only after the failure of well-conducted medical treatment: only 23% of patients in the present series underwent surgery as first intention. All the patients operated on by Jardé [16] had been given orthopedic treatment before tarsectomy. Nineteen of Méary’s 45 patients (42%) had histories of surgery [7]. In the present series, 12 feet had histories of surgery to some extent. No influence of prior surgery on outcome could, however, be demonstrated, due to the heterogeneity of the techniques employed. Feet that have undergone bone surgery stiffen, making forefoot balance difficult to achieve [15,22]. Failure of surgical correction of pes cavus leads to treatment escalation which quickly results in serious functional consequences (as in the case of double arthrodesis) or exhausts the possibilities of surgery.

Peroperative complications

Peroperative complications occurred in five cases (13%)—all of the same nature, secondary to large-scale bone resection. The correction capacity of anterior tarsectomy is limited: only moderate correction is reported. In our opinion, Tomeno angles greater than 20° cannot be corrected in this way without risking peroperative complications due to excessive bone resection.

Cole [5] and Méary [6,7] stress the absolute obligation to conserve the mediotarsal joint by conserving the proximal osteotomy wall as reference, continuing resection only anteriorly, penetrating the tarsometatarsal joint only in case of necessity. The mediotarsal joint provides forefront pronosupination and abduction—adduction [24,25]: arthrodesis, even partial and/or temporary, induces ankylisis and stiffening of the torsion couple, impairing forefoot adaptation to the ground [7,25] and functional result [7].

Our five patients showed unexpectedly satisfactory results (mean score: 76.8) with forefront mobility conserved in three cases and slightly impaired in two. These large-scale bone resections led to better correction, with a mean Tomeno correction of 18.6°, compared to 14° for the other patients. Only one of the five was free of arthritis, the other four having severe (grade 3) arthritis.

Repeat intervention

Japas [26] performed two surgical revisions, of unspecified nature and cause. Jahss [15] reported three cases of secondary neurological aggravation, without saying whether they received any specific treatment. Wilcox and Weiner [19] reoperated seven patients (two metatarsal osteotomies, one calcaneal valgization osteotomy, and four double arthrodeses), but did not say why.

We were obliged to reoperate seven of our patients for tarsectomy failure, mainly due to faulty indication and technique. Any residual equinus at end of surgery should be corrected by lengthening the calcaneal tendon. The correction capacity of anterior tarsectomy is limited; where deformity is severe, either bone resection is insufficient and some deformity persists, or it is excessive, leading to mediotarsal joint space arthritis. Anterior tarsectomy for neurologic pes cavus should be indicated only with caution.

Clinical results

The prime symptom of decompensated pes cavus is pain. Where persistent, it is in 60% of metatarsalgia cases, not always related to hypocorrection. Plantar callosities with long evolution may cause irreversible plantar lesions and enduring pain even without any bone abnormality [6,27]. Méary et al. [7] obtained regression of metatarsalgia in 76% of cases, with total cessation in 10 cases (29%) and significant reduction in 12.

Our results here match those in the literature: the impact of surgery on pain was effective in 75% of cases, significantly alleviating metatarsalgia.

In the present series, 68% of patients recovered near-normal everyday activity.

Walking distance recovery was even better, with more than 75% able to walk unlimited distances. This is an especially satisfying result inasmuch as walking was hindered by the deteriorated general state and neurological disorders of certain patients.

66.7% of cases showed residual clawfoot. Méary et al. [7] was able to reduce clawfoot in 10 cases out of 17; thus, anterior tarsectomy did not automatically correct clawfoot, even though reduction was possible. Clawfoot should, even so, be corrected, as it impairs the functional and anatomic result. Specific intervention is not necessary if, at the end of surgery, the toes have spontaneously recovered normal positioning. Méary [6] recommends interphalangeal arthrodesis; we prefer interphalangeal arthroplastic resection, which has the advantage of conserving mobility.

Calcaneal tendon lengthening is not indicated until the cavus has been corrected. There is often no more than a pseudo-equinus due to forefront plantar flexion, which tarsectomy corrects [17,27,28], making calcaneal tendon lengthening superfluous. Residual equinus after osteotomy, on the other hand, is to be corrected by lengthening the calcaneal tendon: equinus prevents the dorsal movement of the foot involved in the step, causing considerable mechanical overload to the forefront, with
Radiographic results

The mean angles measured preoperatively in the present series bear witness to the severity of the deformities: Djian = 100°, Tomeno = 23°, calcaneal slope = 30.8°. In Jardé’s series [16], the mean Djian angle was 108°. We were unable to establish prognostic values for these preoperative angles, although it would seem only logical that the risk of hypocorrection should be proportional to the degree of initial deformity. More important than the angles themselves, however, is the correction capacity — and this we have demonstrated to depend on foot joint flexibility.

Only the postoperative Tomeno angle impacted the functional score. Normalizing the Méary-Tomeno line should be the defining objective for surgical correction of anterior or mixed pes cavus, as many authors have already stressed [6,7,17,21]. Realigning the talar and 1st-metatarsal axes both corrects the cavus and reduces pronosupination imbalance [7].

The Djian angle would seem to have more of a diagnostic than therapeutic or prognostic value, and in our experience is less discriminatory or influential than the Tomeno angle.

Hindfoot varus was corrected in 65.2% of the present cases. Méary et al. [7] obtained varus correction in 75.8% of cases and Melka et al. [21] in 55%. Restoring hindfoot alignment seems to us to be imperative, and strongly correlated with satisfactory functional results. Restoring physiological hindfoot valgus ensures the stability of the anatomic result over time: external translation of the calcaneus causes the action of the triceps, which is pronatory when there is varus [28], to become supinatory again, preventing recurrence [6].

Tarsectomy seems to be sufficient to correct calcaneal varus. Calcaneal supination is a compensatory phenomenon, enabling the forefoot, which is in irreducible pronation, to recover plantar weight-bearing [23]. If the calcaneal varus has remained flexible and reducible, correcting the forefoot deformity automatically corrects that of the hindfoot in the frontal plane [22]. Deformity reducibility can be tested on a Coleman Block. Calcaneal valgization osteotomy does not seem to us to be systematically indicated, but is rather to be decided on during surgery in the light of the varus persisting on the peroperative images.

There has, to the best of our knowledge, been no study of the incidence of arthritis secondary to anterior tarsectomy for pes cavus or of its impact on functional outcome. Arthritis was very frequent in the present series, affecting 74% of feet. It was symptomatic, implicated in the pain and joint stiffening that impaired patients’ activity. It impacts functional outcome.

The subtalar was the most frequently affected joint — but was rarely symptomatic and thus often well-tolerated.

The mediotalar joint was the most severely affected, with grade-III lesions in 35% of cases; yet its impact was limited, affecting neither functional results nor fore- or hindfoot mobility.

Paradoxically, it was the tarsometatarsal joint that had the greatest impact on functional score and forefoot mobil-


