Midterm Follow-Up of Talectomy for Severe Rigid Equinovarus Feet

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ABSTRACT

Rigid equinovarus foot is a challenging problem. Talectomy has been advocated as a salvage procedure to achieve a plantigrade painless foot in the treatment of rigid equinovarus deformity. The present prospective observational study evaluated the effectiveness of talectomy in the treatment of Dimeglio grade IV rigid equinovarus feet. Nineteen feet in 13 patients were treated by talectomy from September 2001 through January 2012 (10-year, 2-month period). Of the 13 patients, 9 (69.23%) had a foot deformity due to arthrogryposis multiplex congenita and 1 (7.69%) each due to sacral agenesis, spastic cerebral palsy, neglected congenital talipes equinovarus, and post-traumatic contracture. Of the 13 patients, 9 (69.23%) were male and 4 (30.77%) were female. Their mean age was 7.7 (range 3 to 26) years. The mean follow-up duration was 6.4 (range 2 to 11) years. Along with talectomy, excision of the navicular was performed in 8 feet (42.11%), calcaneal osteotomy with a laterally based wedge in 8 (42.11%), and calcaneocuboid fusion in 3 feet (15.79%). Postoperatively, all the feet improved to Dimeglio grade II and were painless, and 16 feet (84.22%) were plantigrade; 1 foot (5.26%) had residual equinus resulting from incomplete removal of the talus and 2 (10.53%) had residual varus. Also, 3 feet (15.79%) had forefoot adduction (2 residual and 1 recurrent) that required a second surgery to correct the deformity. From our experience, talectomy is an effective procedure for correction of severe rigid equinovarus feet, provided that the talus is completely removed and the calcaneus is positioned correctly in the ankle mortise.

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adduction, and foot supination). The reducibility of each deformity is determined and scored (0 to 4) in terms of the angulation of deformity: –20° to <0° is given a score of 1; 0° to <20°, a score of 2; 20° to <45°, a score of 3; and 45° to 90°, a score of 4. Thus, the severity of the deformity is graded from 1 to 4 points. Other clinical findings are also considered, including the presence of a posterior or medial crease, pes cavus, and poor muscle function. When any of these additional conditions is present, an additional point is added to the score for each additional finding. A final score, ranging from <5 to 20, is determined and the foot graded from I (least deformity) to IV (most deformity). A score of 1 to <5 is categorized as a grade I deformity (least severe), a score of 5 to 10 as a grade II deformity, a score of 10 to <15 as a grade III deformity, and a score of 15 to <20 is categorized as a grade IV deformity (most severe).

The clinical evaluation of each patient was also described in terms modified by Legaspi et al. (12), and the feet were graded as good, fair, or poor. A grade of “good” indicates a painless, plantigrade foot without deformity and a satisfied patient. In contrast, a grade of “fair” indicates a painless foot with residual deformity that requires surgical correction. Finally, “poor” indicates a painful foot with residual or recurrent deformity that requires surgical correction. The radiologic evaluation was performed using plain film radiographic measurement of the standing lateral tibiocalcaneal angle.

### Statistical Analysis

Statistical analyses were conducted using IBM® SPSS® Statistics software, version 22 (IBM Corp., Armonk, NY). Data are presented as the median and range and counts and percentages for nonparametric measures and categorical data. Tests of the null hypothesis between 2 independent groups for nonparametric data were conducted.

### Surgical Technique of Talectomy

The approach used in the present series was anterolateral after the method described by Green et al. (13). The operation was performed with the patient under general anesthesia combined with a caudal block, with a thigh tourniquet on the ipsilateral extremity. An anterolateral incision was made over the ankle and extended distally to the level of the navicular, and the head and neck of the talus were exposed starting from the anterior aspect of the ankle. The Achilles tendon was lengthened using Z-plasty by way of a second incision made directly over the tendon. In cases with a fibrotic, adherent Achilles tendon, excision of a portion of the tendon was performed. Thereafter, complete removal of the talus was performed, and the foot was easily corrected to the neutral, plantigrade position. Posterior displacement of the foot was undertaken until the middle facet of the calcaneus was situated directly under the tibial plafond and, if needed to achieve this alignment, the navicular was also excised. After ascertainment of the desired position was visualized directly and using an intraoperative image intensifier, 2 tibiocalcaneal Kirschner wires or a Steinmann pin was used to temporarily stabilize the correction, with the wires or pin directed from plantarly to proximally (intramedullary). Adjunct midfoot and forefoot procedures were also performed on an as-needed basis, and a below-the-knee plaster cast was applied for the first 8 postoperative weeks. Thereafter, a custom-fitted, below-the-knee ankle-foot orthosis (a plastic, custom, below-the-knee, foot and ankle orthosis without a custom foot insole) was used for ≥1 year after the surgery. One of us (M.E.) performed all the operations.

### Table 1

<table>
<thead>
<tr>
<th>Etiology of Rigid Equinovarus</th>
<th>Patients/Feet (n)</th>
<th>Age (y)</th>
<th>Sex (M/F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMC</td>
<td>9 (69.23)/14 (73.68)</td>
<td>5.3 (3 to 10)</td>
<td>7 (53.84)/2 (15.38)</td>
</tr>
<tr>
<td>Old neglected CTEV</td>
<td>1 (7.69)/1 (5.26)</td>
<td>26</td>
<td>1 (7.69) (M)</td>
</tr>
<tr>
<td>Sacral agenesis</td>
<td>1 (7.69)/1 (5.26)</td>
<td>6</td>
<td>1 (7.69) (F)</td>
</tr>
<tr>
<td>CP spastic diplegia</td>
<td>1 (7.69)/2 (10.53)</td>
<td>12</td>
<td>1 (7.69) (M)</td>
</tr>
<tr>
<td>Post-traumatic</td>
<td>1 (7.69)/1 (5.26)</td>
<td>10</td>
<td>1 (7.69) (F)</td>
</tr>
</tbody>
</table>

Abbreviations: AMC, arthrogryposis multiplex congenital; CP, cerebral palsy; CTEV, congenital talipes equinovarus; F, female; M, male.

Data presented as n (%); for age, the data in parentheses are the range.

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Fig. 1. Preoperative clinical photograph and standing plain radiographs of the patient with cerebral palsy (patient 9). (A) Anterior view. (B) Posterior view. (C) Plain film lateral radiograph of the right foot. (D) Plain film lateral radiograph of the left foot. Tibio/Calc A, tibiocalcaneal angle; Calc/1st Met. A, calcaneus–first metatarsal angle.
using the Wilcoxon rank sum test or chi-square test. Differences between the Dimeglio scores and radiographic measurements were compared using Student’s paired t test. Statistical significance was defined at the 5% ($p \leq 0.05$) level.

Results

Our patient population included 19 feet in 13 patients, and their mean age was 7.7 (range 3 to 26) years. Of the 19 feet, 14 (73.68%) had resulted from arthrogryposis multiplex congenita (AMC), 1 (5.26%) from neglected congenital talipes equinovarus, 1 (5.26%) from sacral agenesis, and 2 (10.53%) from cerebral palsy with spastic diplegia; 1 (5.26%) was post-traumatic (Table 1). Of the 13 patients, 12 (92.31%) had previously undergone posteromedial release (PMR), and 1 patient (7.69%; 2 [10.53%] operated feet) had not previously undergone PMR. Four feet (21.05%) had also undergone previous revision PMR. All patients were ambulatory; however, 4 (30.77%) required bilateral handheld support (crutches or walker) preoperatively (patients 5, 6, 9, and 13). The patient with cerebral palsy (patient 9) had been classified as grade III according to the Gross Motor Function Classification System (GMFCS)(10,11). Patient 9 with cerebral palsy improved from grade III to grade II. At the final follow-up visit, all patients had painless feet, with independent ambulation without handheld support (no crutches or walker required), and all the patients were satisfied (Figs. 1 to 4). Furthermore, the natural progression of the interface between the tibia and the residual tarsal bones after tallectomy primarily entails the development of a functional pseudoarthrosis consisting primarily of scar tissue (Figs. 2C and D and 4C and D). This requires the use of the custom ankle-foot orthosis to minimize instability and guide alignment.

All 19 feet underwent tallectomy performed by the same surgeon (M.E.). Complete subtalar release (CSTR) was performed as the primary (index) procedure in 2 (10.53%) of the 19 feet, and the decision to undertake tallectomy was made during the course of the surgery according to the operative findings (Figs. 3 and 4; Table 2). Tallectomy was performed as a primary intervention in just 2 of the 19 feet (10.53%). Furthermore, adjunct surgical procedures were performed in 15 of the 19 feet (78.95%), including naviculec- tomy in 8 feet (42.11%), calcaneocuboid fusion in 3 (15.79%), calcaneal osteotomy in 8 (42.11%), and PMR in 3 feet (15.79%). The mean follow-up duration was 6.4 (range 2 to 11) years, and postoperative clinical and radiographic evaluations were conducted at 6-month intervals after tallectomy.

Using the Dimeglio scale, all feet had improved from grade IV with a preoperative mean score of 16.1 ± 1.1 ($p \leq 0.0001$) after tallectomy (with or without adjunct surgery; Table 3). Clinically, 16 feet (84.21%) were plantigrade. We observed a good outcome in 13 feet (68.42%) and a fair outcome in 6 (31.58%). Three feet (15.79%) had a residual hindfoot deformity (1 with equinus and 2 with varus), and 3 feet (15.79%) had adduction (2 residual and 1 recurrent), which necessitated additional operative correction. Radiologically, the mean preoperative lateral tibiocalcaneal angle was 130° ± 20.5° (range 90° to 146°). Postoperatively, it was 88° ± 27.5° (range 60° to 118°), and the difference was statistically significant ($p < .001$).

Regarding complications, residual deformities occurred in 6 feet (31.58%) in 4 patients (30.77%; 3 with AMC and 1 with cerebral palsy; patients 1, 5, 9, and 13). One foot (5.26%) had residual equinus (15° plantar flexion) owing to incomplete removal of the talus, 2 feet (10.53%) had residual varus of ≥5°, 2 (10.53%) had residual adduction...
of 10° and cavus (patient 9), and 1 foot (5.26%) had recurrent adduction of 15° (patient 5). Additional operative correction at a mean duration of 58.67 ± 2.3 months after talectomy was performed for patients 5 and 9. The other 2 patients (patients 1 and 13) declined additional operative correction. Radiographically, we did not observe any cases of spontaneous tibiocalcaneal ankylosis during the observation period.

Discussion

Experience has shown that isolated soft tissue release is an inadequate procedure for the treatment of a severe, rigid equinovarus foot. Despite the improvements gained with serial postoperative casting after soft tissue release, the incidence of residual and/or recurrent deformity is usually high (3,4). In skeletally mature patients, triple arthrodesis is an option, although talectomy is gaining favor compared with triple arthrodesis. However, no clear-cut benefits have yet been confirmed. Some investigators have reported a relatively high incidence of complications with long-term follow-up of triple arthrodesis, including residual deformities requiring additional surgery, pain due to secondary degenerative osteoarthritis, and pseudoarthrosis (14). Others have reported satisfactory subjective outcomes despite the deterioration of function over time and arthritic changes on plain radiographs (5,15). Triple arthrodesis is not the first choice for patients with a neurologic foot deformity, especially in patients with myelomeningocele, because of the danger of joint degeneration and skin ulceration caused by the stiffness of the foot, according to some investigators (16). In skeletally immature patients, ilizarov correction is an alternative that has resulted in satisfactory outcomes reported in the published data. Ilizarov correction was reported in patients with AMC, with an average treatment duration of 18.5 weeks and an average of 2 operations for each of 12 patients, only 3 of whom had Dimeglio grade IV (1). We believe a patient population with more severe deformities would have resulted in an even longer treatment duration. In another report of patients with neurologic feet, the average treatment duration was 10 weeks (7 weeks in an external fixation frame and 3 weeks in a below-the-knee cast). In their subset of patients with more severe deformities, concomitant hindfoot and midfoot osteotomies were performed during the index procedure (7).

Menelaus (4) described the first long-term follow-up period of talectomy in a large series of patients with AMC and spina bifida with rigid talipes equinovarus. He stated that talectomy succeeded where soft tissue release had failed, because it provided sufficient

Fig. 3. Preoperative clinical photograph and plain film radiographic image of patient 13 with arthrogryposis multiplex congenita. (A) Anterior view. (B) Posterior view. (C) Plain film lateral radiograph of the right foot. (D) Plain film lateral radiograph of the left foot.
laxity for the equinovarus deformity to be corrected without tension. The tibiocalcaneal pseudoarthrosis that was created remained stable and relatively congruous in the plantigrade feet. Moreover, the foot had no tendency to relapse owing to the stable position and the absence of medial tension (4). The outcome of talectomy depends on a careful assessment of the deformity and the details of the surgical technique. Talectomy is an effective procedure for correction of hindfoot deformities, and surgeons need to understand that the associated forefoot problems need to be treated as separate entities (12,17).

Fig. 4. Views of patient 13 at the 2-year follow-up point. The surgical procedure included bilateral talectomy and bilateral complete subtalar release, with naviculectomy of the left side. (A) Anterior view. (B) Posterior view. (C) Plain film lateral radiograph of the right foot. (D) Plain film lateral radiograph of the left foot.

Table 2
Study population characteristics, procedures, and outcome (N = 19 feet in 13 patients)

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Age (y)</th>
<th>Sex</th>
<th>Diagnosis</th>
<th>Side</th>
<th>Deformity</th>
<th>Previous Operation</th>
<th>Associated Operations</th>
<th>Complications</th>
<th>Follow-Up Duration (y)</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>Male</td>
<td>AMC</td>
<td>Right</td>
<td>E,V,A,S</td>
<td>PMR</td>
<td>—</td>
<td>Residual E (15°)</td>
<td>11</td>
<td>Fair</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>Male</td>
<td>AMC</td>
<td>Right</td>
<td>E,V,A,S</td>
<td>PMR (twice)</td>
<td>Nav + CCF + STR</td>
<td>—</td>
<td>9</td>
<td>Good</td>
</tr>
<tr>
<td>3</td>
<td>26</td>
<td>Male</td>
<td>Neglected CTEV</td>
<td>Left</td>
<td>E,V,A,S</td>
<td>PMR (twice)</td>
<td>Nav + CCF</td>
<td>—</td>
<td>9.6</td>
<td>Good</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>Female</td>
<td>Sacral agenesis</td>
<td>Left</td>
<td>E,V,A,S</td>
<td>PMR (twice)</td>
<td>Nav + CalO</td>
<td>—</td>
<td>8</td>
<td>Good</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>Female</td>
<td>AMC</td>
<td>Right</td>
<td>E,V,A,S</td>
<td>PMR</td>
<td>—</td>
<td>CalO</td>
<td>8</td>
<td>Good</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td>Male</td>
<td>AMC</td>
<td>Right</td>
<td>E,V,A,S</td>
<td>PMR</td>
<td>—</td>
<td>CalO</td>
<td>7</td>
<td>Good</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>Male</td>
<td>AMC</td>
<td>Left</td>
<td>E,V,A,S</td>
<td>PMR</td>
<td>—</td>
<td>CalO</td>
<td>7</td>
<td>Good</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td>Male</td>
<td>AMC</td>
<td>Right</td>
<td>E,V,A,S</td>
<td>PMR</td>
<td>—</td>
<td>—</td>
<td>5 yr, 3 mo</td>
<td>Good</td>
</tr>
<tr>
<td>9</td>
<td>12</td>
<td>Male</td>
<td>CP spastic</td>
<td>Left</td>
<td>E,V,A,S</td>
<td>PMR</td>
<td>—</td>
<td>Residual A + C</td>
<td>6</td>
<td>Fair</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>Male</td>
<td>GMFCS III</td>
<td>Right</td>
<td>E,V,A,S</td>
<td>PMR</td>
<td>—</td>
<td>Residual A + C</td>
<td>6</td>
<td>Fair</td>
</tr>
<tr>
<td>11</td>
<td>10</td>
<td>Female</td>
<td>Post-traumatic</td>
<td>Right</td>
<td>E,V</td>
<td>PMR (twice)</td>
<td>—</td>
<td>—</td>
<td>5.3</td>
<td>Good</td>
</tr>
<tr>
<td>12</td>
<td>3</td>
<td>Male</td>
<td>AMC</td>
<td>Left</td>
<td>E,V,A,S</td>
<td>PMR</td>
<td>—</td>
<td>CalO</td>
<td>5.3</td>
<td>Good</td>
</tr>
<tr>
<td>13</td>
<td>3</td>
<td>Female</td>
<td>AMC</td>
<td>Right</td>
<td>E,V,A,S</td>
<td>CSTR</td>
<td>—</td>
<td>CalO</td>
<td>2</td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>AMC</td>
<td>Left</td>
<td>E,V,A,S</td>
<td>Nav + CSTR</td>
<td>—</td>
<td>Varus</td>
<td>2</td>
<td>Fair</td>
</tr>
</tbody>
</table>

Abbreviations: A, adduction; C, cavus; CalO, calcaneal osteotomy; CCF, calcaneocuboid fusion; CSTR, complete subtalar release; CTEV, congenital talipes equinovarus; E, equinus; GMFCS, Gross Motor Function Classification System; Nav, naviculectomy; PMR, posteromedial release; S, supination; STR, soft tissue release; V, varus.

* Good indicates a painless, plantigrade foot without deformity and a satisfied patient; fair indicates a painless foot with residual or recurrent deformity that requires surgical correction; and poor indicates a painful foot requiring surgical correction.
Comparison between 2 dependent groups for parametric data performed using a signiﬁcant test; the probability of error at .05 was considered signiﬁcant and at .01, highly signiﬁcant.

Table 3
Preoperative and postoperative Dimeglio scores

<table>
<thead>
<tr>
<th>Score</th>
<th>Feet (n)</th>
<th>Mean</th>
<th>SD</th>
<th>t</th>
<th>p Value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>Preoperative 19</td>
<td>16.105</td>
<td>1.7605</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Postoperative 19</td>
<td>7.895</td>
<td>1.1002</td>
<td>17.514</td>
<td>&lt;.0001</td>
<td>HS</td>
</tr>
<tr>
<td>Supination</td>
<td>Preoperative 19</td>
<td>54.737</td>
<td>30.5266</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Postoperative 19</td>
<td>34.211</td>
<td>5.5934</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adduction Preoperative 19</td>
<td>1.053</td>
<td>2.0943</td>
<td>24.817</td>
<td>&lt;.0001</td>
<td>HS</td>
</tr>
<tr>
<td>Varus</td>
<td>Preoperative 19</td>
<td>27.895</td>
<td>12.7275</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Postoperative 19</td>
<td>24.737</td>
<td>21.6329</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equinus</td>
<td>Preoperative 19</td>
<td>24.737</td>
<td>21.6329</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Postoperative 19</td>
<td>24.737</td>
<td>21.6329</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: HS, highly signiﬁcant (p < .01); SD, standard deviation.

Numerous associated procedures have been reported in published studies at the same time of the index procedure. The tarsal navicular can be excised if necessary to obtain adequate posterior displacement of the calcaneus (13,18). Calcaneocuboid fusion was shown to decrease the incidence of recurrent deformity in children (2). The most commonly reported complication has been residual deformity. Usually, the deformity results from a technical error during surgery. The technical errors include incomplete removal of the talus and incorrect positioning of the calcaneus in the ankle mortise (4,8,12,19). In contrast to the classic recommendation, Cassis and Capdevila (20) found no correlation between the presence of residual talus and the outcome. However, the size of the residual talus and whether articular cartilage or bony talus had been left behind was not reported (20). Legaspi et al (12) found no correlation between the degree of posterior displacement of the calcaneus relative to the tibial mid–axis and talocalcaneal arthritis, and all their patients wore normal shoes. A similar ﬁnding was reported by Cooper and Capella (8) in their long-term follow-up study.

The results of our study have conﬁrmed those of numerous reports that talezectomy offers a simple and effective correction of rigid equinovalvarus feet. The treatment duration was approximately 8 weeks on average, with follow-up examinations at 4 and 8 weeks postoperatively. Subsequently, mobilization was started with the patient in a below-the-knee splint. We had good results in 13 of 19 feet (68.42%) and a fair outcome in 6 feet (31.58%). None of our patients experienced a poor outcome. Furthermore, no cases of foot pain were reported after talectomy. We believe that the fair results were related to a failure to address all deformity components with concomitant procedures. Also, we undertook adjunct procedures in 14 of the 19 feet (73.68%) on which we performed talectomy. The limitations of the present observational case series included the small sample size, although we were able to show statistically signiﬁcant differences in the outcome measures. More importantly, however, the limited functional demands of our patient population probably inﬂuenced the favorable outcomes we observed. Thus, a more active patient population might have resulted in different outcomes. Other biases that likely inﬂuenced our ﬁndings were the single surgeon series and that the outcome assessments were performed by the operating surgeon and others related to the patients’ treatment. Despite these limitations, the ﬁndings we have described could be used in the development of future randomized controlled trials and prospective cohort studies focusing on the surgical care of the rigid equinovalvarus foot.

In conclusion, talectomy is an effective procedure for the treatment of rigid, severe equinovarus feet with a grade IV Dimeglio classiﬁcation. Talectomy is used primarily to correct hindfoot deformity, provided that the talus is completely removed and the calcaneus can be aligned in the ankle mortise. Any associated mid- and/or forefoot deformity should be addressed with adjunct surgical interventions. Finally, talectomy is relatively straightforward and does not require a great amount of surgical time and relieves neurovascular tension and allows early mobilization of the operated extremity. From our experience with talectomy, we believe it is a viable alternative for the surgical treatment of rigid, severe, equinovalvarus foot deformity.

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References

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