



Results of Bone and Soft Tissue Surgery Combined with Arthrodesis of the Talocalcaneal and Calcaneocuboid Joints for Equinovarus Associated with Spina Bifida

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Abstract

Whether arthrodesis is necessary for correcting equinovarus associated with spina bifida in children to prevent its recurrence is controversial. In this retrospective study we determined the outcomes of bone and soft tissue surgery combined with arthrodesis of the talocalcaneal and calcaneocuboid joints for equinovarus associated with spina bifida. The subjects were five patients, with a mean age of 6 years, who underwent surgery. Complications, the presence or absence of callus, reverse deformation, clinical assessment, evidence of osteoarthritis, and range of motion of the ankle (assessed by plain radiography) were investigated. A fracture occurred postoperatively in the proximal tibia during below-knee casting of one foot. No callus formed in any patient, and mild reverse deformation was observed in three feet. The clinical assessment was good in all cases. There was no osteoarthritis. The tibiocalcaneal and tibiotalar angles in maximum dorsiflexion were significantly less after surgery than before it. Bone and soft tissue surgery combined with arthrodesis of the talocalcaneal and calcaneocuboid joints may be necessary to prevent recurrence of equinovarus.

Keywords: Ankle joint; Arthrodesis; Equinovarus; Foot; Spina bifida

Introduction

Equinovarus associated with spina bifida is caused by a flaccid paralysis-induced imbalance of muscle strength and malpositioning. Surgery for this condition is necessary when intractable calluses are formed because of the inability to contact the ground with the soles of the feet (plantigrade) and rigid equinovarus. Imbalance of muscle strength, however, changes with growth, and deformation recurs in many cases after soft tissue release alone. Deformation seldom recurs after triple arthrodesis, but the talocrural joint develops osteoarthritis during growth [1,2] because it cannot preserve talocalcaneal, calcaneocuboid, and talonavicular joint motion. Treatment of equinovarus associated with spina bifida is difficult. At our hospital, bone and soft tissue surgery combined with arthrodesis of the talocalcaneal and calcaneocuboid joints is performed in patients with equinovarus associated with spina bifida. We retrospectively investigated the postoperative outcomes of this condition.

Methods

In this case series, the subjects were patients who had undergone bone and soft tissue surgery combined with arthrodesis of the talocalcaneal and calcaneocuboid joints for equinovarus associated with spina bifida at our hospital between March 2006 and August 2012. Inclusion criteria were as follows: The surgery had been performed at least 1 year previously at levels 4 and 5, according to Sharrard [3] in patients who [1] had been able to walk but had difficulty wearing shoes and orthoses, [2] were unable to contact the ground with the soles of the feet despite attachment of an orthosis, and [3] had intractable callus formation causing rigid equinovarus. The exclusion criteria were as follows: Surgery had been performed less than 1 year previously at levels 1–3, according to Sharrard [3], indicating an inability to walk and flexible equinovarus. Six feet of five patients were investigated (four right feet and two left feet).

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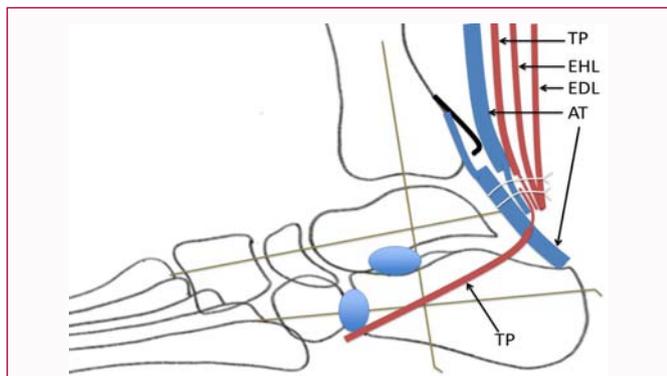


Figure 1: Bone and soft tissue surgery combined with arthrodesis of the talocalcaneal and calcaneocuboid joints. TP: posterior tibial tendon; FHL: flexor hallucis longus tendon; FDL: flexor digitorum longus tendon; AT: Achilles tendon.

Technique

Plans for bone and soft tissue surgery combined with arthrodesis of the talocalcaneal and calcaneocuboid joints were designed by one of the authors. The surgery included posteromedial release [4-6], which was applied through the medial side of the foot, after which the talocalcaneal and calcaneocuboid joints were released through the lateral side of the foot. The operation began with a medial incision at the medial cuneiform. The cut passed through a medial malleolus and was extended until it was just distal to the calf, thereby exposing the Achilles tendon, similar to the medial Turco incision. The Achilles tendon sheath was incised to expose the Achilles tendon, which was lengthened by Z-lengthening. Similarly, the posterior tibial (PT) and flexor digitorum longus (FDL) tendons' sheaths were incised to expose the PT and FDL, which then underwent Z-lengthening. After the posterior tibial neurovascular bundle was identified and protected posteromedially, the flexor hallucis longus (FHL) tendon was identified and protected as well. The ankle capsule was exposed and incised from the posteromedial to the posterolateral corners. The posterior tibiofibular and calcaneofibular ligaments were exposed and released to allow maximum dorsiflexion of the talus. The superficial tibionavicular, spring, bifurcate, and plantar calcaneocuboid ligaments were released through the medial side of the foot. If the hallux was tightly flexed, the FHL was lengthened by Z-lengthening. Next, the incision was made from the end of the lateral malleolus through the upper edge of the calcaneocuboid joint to the base of the third metatarsal bone. The extensor digitorum brevis muscle was identified and incised, and the lateral calcaneocuboid joint and the sinus tali were exposed. The articular cartilage in the calcaneocuboid joint and the sinus tali were resected to allow bone union. After these releases were complete, the foot was corrected in sequence using the modified Ponseti method [7,8]. First, the pronated forefoot was supinated while plantarflexing the cuboid, with the foot stabilized by

the thumb and index finger over the heel. The calcaneocuboid joint was then fixed using a pin. Second, with counter pressure by the thumb against the head of the talus, the forefoot was abducted and dorsiflexed with the foot stabilized using the thumb and index finger over the heel. The talonavicular joint was fixed using a pin. Finally, the talocrural joint was fixed with a pin.

After this sequence, arthrodesis was performed in those joints through the lateral side of the foot. Additionally, tenodesis was applied to the Achilles tendon and the PT, FDL, and FHL tendons on the posterior side of the ankle through the medial side of the foot (Figure 1). Casting was applied for 8 weeks after surgery, and an ankle-foot orthosis was attached thereafter for 1 year.

The outcomes of the patients were evaluated at the final follow-up more than 1 year after surgery, including the following items: complications, presence or absence of callus, reverse deformation, clinical assessment according to Neto et al. [9], evidence of osteoarthritis, and the range of motion (ROM) of the ankle joint as assessed on plain radiographs. We defined reverse deformation as valgus deformity of the heel, even if it was only slight. For this clinical assessment [9], "good" indicated that the condition was favorable in the posterior and anterior regions of the foot, "fair" indicated that the condition was favorable in the posterior region but unfavorable in the anterior region, requiring surgery and "poor" indicated that the condition was unfavorable in the posterior and anterior regions and required secondary surgery. For assessing the ROM of the ankle joint, the tibiocalcaneal (TiCa) and tibiotalar (TiTa) angles [10] were measured on plain lateral radiographs of the foot in maximum dorsiflexion before and after surgery.

For statistical analysis, we used IBM SPSS version 20 software (Chicago, IL, USA). TiCa and TiTa angles before and after surgery were compared using the Wilcoxon rank-sum test. A value of $p = 0.05$ was regarded to indicate statistical significance.

Results

One foot of a boy and five feet of five girls were evaluated. The mean age at the time of surgery was 6 years (4–8 years). Four right feet and two left feet had been treated, and the mean duration of follow-up was 76 months (37–113 months) (Table 1). Regarding complications, a fracture occurred at the site of bone collection in the proximal tibia during below-knee casting of one foot. No callus formed in any patient, and mild reverse deformation was noted in three feet. The clinical assessment established by Neto et al. [9] was "good" in all cases (Table 2) (Figure 2 and 3). There was no evidence of osteoarthritis. The TiCa angles before and after surgery, respectively, were as follows: median 85° and 57.5°, maximum 100° and 75°, minimum 70° and 45°. The TiTa angles before and after surgery, respectively, were as follows: median 110° and 92.5°, maximum 135° and 100°, minimum 95° and 85°. The angles, measured in maximum dorsiflexion, were

Table 1: Patient's Demographics.

Patient	Sex	Age (years)	Side	Observation period (months)
1	Female	4	Right	113
2	Female	4	Left	111
3	Female	6	Left	37
4	Male	7	Right	73
5	Female	8	Left	73
6	Female	5	Right	49

Table 2: Patient's outcomes.

Patient	Complication	Callus	Reverse (valgus) deformation	Clinical assessment
1	Fracture of the tibia	Absence	None	Good
2	None	Absence	Mild	Good
3	None	Absence	Mild	Good
4	None	Absence	Mild	Good
5	None	Absence	None	Good
6	None	Absence	None	Good

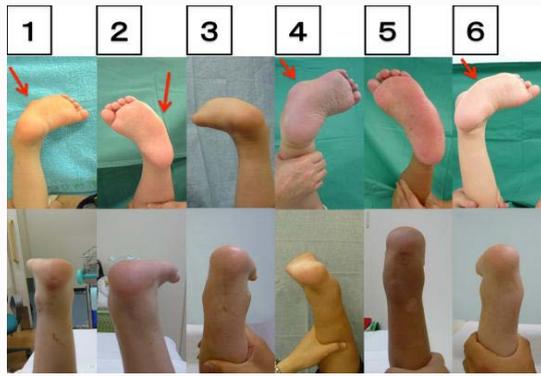


Figure 2: Preoperative and postoperative photographs of all six cases. Equinovarus was noted in all of the feet, and the patients walked by contacting the ground with the lateral sides of the feet, leading to callus formation at the base of the fifth metatarsus (arrows). Adduction and varus were observed in the anterior and posterior regions of the feet, respectively.



Figure 3: Postoperative photograph shows weight-bearing stature.



Figure 4: Lateral radiograph of the normal foot in maximum dorsiflexion. Normal values of the tibiotalar (TiTa) and tibiocalcaneal (TiCa) angles in a lateral radiograph of the foot in maximum dorsiflexion are 113.69 ± 11.21 and 67.79 ± 10.63 .

significantly lower after surgery than before surgery ($p = 0.03$) (Figure 4-6) [11].

Discussion

Neto et al. [9] performed posterior mediolateral release, and the outcomes after a mean of 86 months of follow-up were good in 49 of 63 feet (63%), fair in 9 (14%), and poor in 14 (23%). Flynn et al. [12] performed posteromedial release, and the outcomes at a mean of 36 months after surgery were good in 45 of 72 feet (61%), fair in

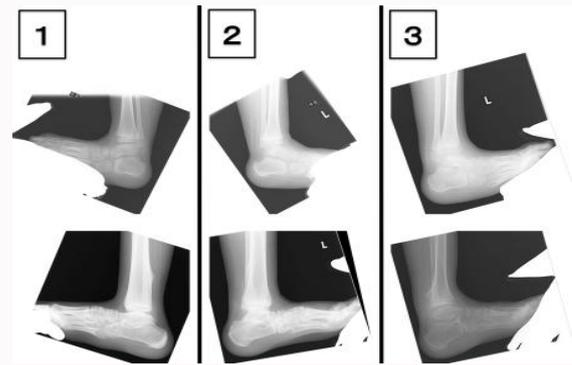


Figure 5: Preoperative (top panels) and postoperative (bottom panels) lateral radiographs of patients 1–3 with the feet in maximum dorsiflexion.

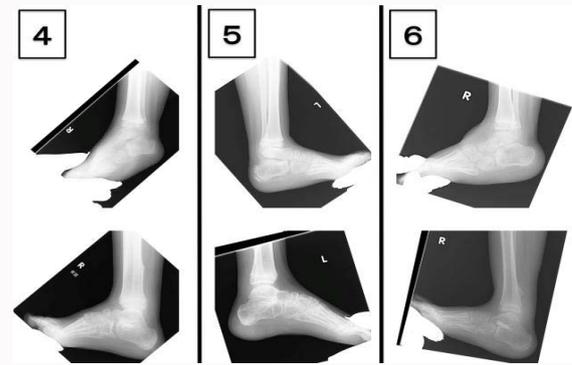


Figure 6: Preoperative (top panels) and postoperative (bottom panels) lateral radiographs of patients 4–6 with the feet in maximum dorsiflexion.

18 (26%), and poor in 9 (13%). Soft tissue release operations, such as posteromedial and posterior mediolateral release, have been performed to correct deformity and equalize muscle strength, but the deformation recurrence rate is high. The deformation recurrence rate after surgical arthrodesis, such as triple arthrodesis, is low [1,2], but this technique is generally avoided because osteoarthritis may develop in the adjacent talocrural joint, resulting in restriction of ROM in the talocalcaneal, talonavicular, and calcaneocuboid joints in the future. Whether arthrodesis is necessary to correct equinovarus associated with spina bifida in children is controversial. Bone and soft tissue surgery combined with arthrodesis of the talocalcaneal and calcaneocuboid joints achieved a “good” result in all of our patients. However, mild reverse deformation not requiring surgery was observed in three feet at a mean of 40 months after surgery. Machida et al. [5] also reported that deformation did not recur in any of 34 feet concomitantly treated with this surgery after a mean of 12.7 years of follow-up. Based on these reports, we consider that arthrodesis of the talocalcaneal and calcaneocuboid joints may be necessary, in addition to soft tissue release operations (e.g., posteromedial release), to prevent recurrence of equinovarus. Machida et al. [5], however, reported that osteoarthritis had occurred in the adjacent talocrural joint in one foot. In our cases, there was no osteoarthritis of the adjacent talocrural joint. However, because these cases have only a short-term follow-up, their course should be followed to observe whether osteoarthritis of the adjacent talocrural joint subsequently occurs. To prevent reverse deformity, we currently perform tendon lengthening and suture of the posterior tibial muscle in the medial side of the foot. We believe that this surgical procedure is necessary to prevent recurrence of equinovarus associated with spina bifida in

children.

The limitations of this case series is that only six feet were investigated and these cases had short-term follow-up.

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