Original Article

The results of Grice Green subtalar arthrodesis of valgus foot in spina bifida

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Abstract

Background: Valgus foot is a common foot deformity in spina bifida. The most popular operation for the valgus deformity has been the Grice talocalcaneal blocking. It has not been studied primarily in children with spina bifida. We report a prospective series, we present the results of hind foot valgus deformity of children with spina bifida, using Grice talocalcaneal arthrodesis with a tricortical iliac bone graft.

Materials and Methods: Between May 2000 and December 2003, 21 patients with bilateral (42 feet) valgus deformity of feet underwent surgery. There were 7 males and 14 females. The mean age of patients was 67.7 months (range 50–108 months).

Results: The total number of feet that had nonunion was 11, in 7 of them the grafts were completely reabsorbed and the outcome of all these feet was unsatisfactory. Four feet had partial union of which three had unsatisfactory and one had satisfactory outcome. Sixteen feet had residual valgus deformity at the last followup visit, 10 patients had nonunion, and 6 had inadequate correction. Mean preoperative talocalcaneal and calcaneal pitch angles were 48.5° and 31.9°, respectively, which decreased to 38.5° and 29.1°, respectively, postoperatively. The decrease in talocalcaneal angle and calcaneal pitch was significant between preoperative and postoperative measurements ($P<0.05$).

Conclusion: Grice subtalar arthrodesis technique is still a valuable option for valgus foot in patients with spina bifida. In this study, we found more encouraging results in older patients.

Key words: Grice Green, spina bifida, valgus foot, subtalar arthrodesis

Introduction

Spina bifida is generally accompanied by a high incidence of foot deformities and valgus feet make up to 7–12% of all foot deformities.[1,2] The pathoanatomy of valgus deformity of hind foot is the rotational malalignment of talus and calcaneus due to talonavicular–calcaneocuboid subluxation.[3] The deformity is mostly present at birth and characterized by a shortened fibula, wedging of tibial epiphysis, valgus position of the hind foot relative to the leg, and marked dorsiflexion.[4] Patients commonly have significant disability from combination of valgus deformity of the ankle and subtalar joints with the late tibial torsion and plano-abduction deformity of the foot.[5] It is essential that an accurate diagnosis of valgus foot is established early and therapy is instituted. The initial treatment is conservative consisting of manipulation and orthotics.[6] With the use of orthotics, an attempt is made to counteract the predominant valgus force. On the other hand, sometimes the satisfactory fitting of feet with orthotics may not be possible. Failed orthotic treatment may itself arise as a source of problem in such cases. Ulcers, callosities, and shoe wrecking are the common problems caused by such unsatisfactory fitting orthotics. In this condition, the feet with valgus deformity should be surgically corrected. Batchelor technique and Dennyson-Fulford modification[7-10] of this technique are popular operations in recent years; however, some important complications are reported for these techniques. On the other hand, a safer extra-articular subtalar arthrodesis technique, the Grice talocalcaneal blocking,[11] has been considered as the most popular operation for the valgus deformity.[12-14]

Since May 2000 we operated hind foot valgus deformities

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which are failed in conservative treatment. Although the outcome of Grice talocalcaneal arthrodesis in paralytic feet has been documented in various studies, its use in spina bifida is documented in limited series. We report a prospective series, we present the results of 42 feet with hind foot valgus deformity of children with spina bifida, using Grice talocalcaneal blocking with a tricortical bone graft.

Materials and Methods

Between May 2000 and December 2003, 42 feet (21 patients) with valgus deformity underwent surgery. There were 7 male and 14 female patients with a mean age of 67.7 months (range 50–108 months). The mean followup period was 45 months (range 32–54 months). All patients had diagnosis of spina bifida with different levels of involvement. The low lumbar and the sacral segments were the most commonly involved regions. The spina bifida lesion was at mid-lumbar region ($n=5$) and at low lumbar and sacral regions ($n=16$). All of them were community ambulators. The valgus foot in patients was diagnosed at routine screening in spina bifida outpatient clinic in our center. Clinical and radiological diagnoses were combined for definitive diagnosis. The clinical diagnosis of valgus foot was made if there was valgus heel on inspection when they were standing [Figure 1] and if the medial head of talus was prominent on palpation.

Patients had orthotic support as an initial treatment. 56 feet of 28 patients were treated with orthosis initially and 42 feet of 21 patient who could not benefit from orthotics were candidates of surgery. The satisfactory fitting of these feet with orthotics was not possible in 32 who had ulcers and callosities. After an informed consent was obtained from the parents, the patients were enrolled into the study group. Children with ankle valgus and fibular growth retardation,[13,14] a deformed and rigid hind foot valgus, and the ones with degenerative subtalar joint changes on radiographs were excluded form the study. Children with syndromic spina bifida were excluded as well.

All of the surgical procedures were performed by one surgeon. The ipsilateral anterior iliac crest was used as the donor of graft. The ipsilateral limb was exsanguinated by applying a soft rubber bandage and the tourniquet was inflated. Through an oblique incision centered over the sinus tarsi, the origin of the extensor digitorum brevis was reflected distally in a tongue-like fashion. The sinus tarsi was visualized and cleared of fat. Then the graft slots were prepared at the undersurface of the talus and on top of the calcaneus just wide enough to receive the graft. The graft was aimed to be placed perpendicular to the subtalar joint.[15] No internal fixation was needed in any of the cases after locking the graft at its slots. The tourniquet was deflated and the hemostasis ensured. The incisions were closed with subcuticular absorbable sutures and the foot was immobilized in neutral position by short leg plaster splint. Achilles tendon lengthening was not performed in any patient.

A short leg cast was applied after removal of the sutures (post-op 10–12 days). At the fourth week, the patients were instructed to begin weight-bearing. The short leg casts were continued until early incorporation of the bone graft was visible on the lateral weight-bearing radiographs of the foot. The patients began weight-bearing ambulation while wearing their orthoses. After the treatment, the patients were followed regularly at monthly intervals up to 3 months, every 3 months up to 12 months, and every 6 months up to the last visit. The AP and lateral weight-bearing feet radiographs were obtained at followups. We focused on the following data for the consideration: region where the spina bifida lesion exists,

Figure 1: Clinical photograph showing valgus foot (Rt side) when the patient was weight bearing

Figure 2: X-ray ankle joint (anteroposterior view) showing the union of graft to both talus and calcaneus (black arrow)

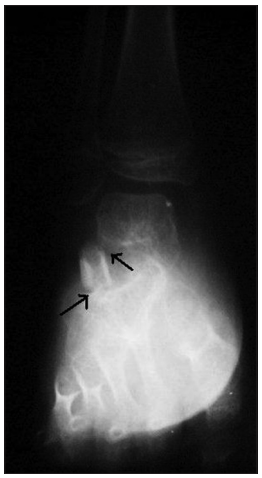

Figure 3: X-ray ankle joint anteroposterior view showing partial union i.e. union of graft to calcaneus but no union to talus (black arrow)

age of the patient, existence of bony union, residual varus or valgus deformity, calcaneal pitch, talocalcaneal angles, reduction in orthotic device use, and the complications.

At 12th week, most of the unions were judged by clinical and radiographic examination. The positive bony union was considered in patients with union of graft to both talus and calcaneus[16] [Figure 2]. If graft union was seen in only at one of them [Figure 3], it was considered as a partial union.

For radiological evaluation, the calcaneal pitch and the lateral talocalcaneal (TC) angles were measured. The calcaneal pitch was the angle formed between the horizontal and a line connecting the tuberosities of the calcaneus. The lateral TC angle was formed between a line paralleling the long axis of the talus and a line connecting the tuberosities of the calcaneus.[17] At surgery, the lateral TC angle was planned to be corrected to 30° and 50° respectively.

For clinical evaluation, we used the criteria of Kling *et al*.,[18] which considers alignment and abnormal callosities. Children who were able to stand with less than 5° of residual valgus posture of the hind foot [Figure 4], had normal callosities, and pain-free mobilization without orthoses were considered as satisfactory. The foot with residual valgus more than 5°, difficulty in fitting to orthoses, or any pain without orthoses during mobilization were considered as unsatisfactory. Any pain during mobilization was considered as the requirement for usage of orthoses.

In the cases of unsuccessful surgical treatment the feet are reoperated. The contralateral anterior iliac crest was used as the donor of graft. A K-wire was used to fix the graft in these cases. Statistical analysis was performed using repeated analysis of variance (ANOVA) and *post hoc* Bonferroni multiple comparisons in comparing preoperative and

Figure 4: A clinical photograph showing satisfactory correction

postoperative angles, and Pearson correlation test was used for finding the relation between age and satisfactory results. Any *P* value smaller than 0.05 was considered significant.

Results

Mean duration of the surgery was 168 minutes (range 115–234 minutes) and the mean blood loss was 98 ml (range 60–184 ml). The average duration of plaster immobilization was 9 weeks (range 7–12 weeks). 26 feet had clinically satisfactory outcome while 16 feet were unsatisfactory outcome. Both feet of a patient in the group with unsatisfactory outcome were reoperated recently. The mean age of the patients with clinically unsatisfactory and satisfactory outcomes was 57.7 and 73.8 months, respectively. The age at the time of surgery in patients with unsatisfactory outcome was significantly lesser than of those with a satisfactory outcome ($P<0.0001$).

The total number of feet that had nonunion was 11; in 7 of them the grafts were completely reabsorbed and all these feet had an unsatisfactory outcome. Four feet had partial union of which three had unsatisfactory outcome and one had satisfactory outcome. In a foot with satisfactory outcome (EGu), the partial graft union was observed to calcaneus. The lateral TC angle of this foot at the last followup visit was 43°. It was clinically stable and painless, and there was no need for the orthotic devices. Two feet had nonunion and they were reoperated. We used K-wire to fix the graft and maintain the correction.

Sixteen feet had residual valgus deformity more than 5° at the last followup visit, 10 patients had nonunion, and 6 had inadequate correction. Varus deformity was not seen in any of the feet. Mean preoperative TC angle was 48.5° (range 39-59° SD: 3.20976) which decreased to 38.5° (range 27-59°; SD: 7.60039) postoperatively [Figure 5]. The preoperative mean calcaneal pitch angle was 31.9° (range 22-37°; SD: 2.91179) which decreased to 29.1° (range 22-36°; SD: 4.20110) postoperatively [Figure 6].

The decrease in TC angle and calcaneal pitch angle was significant between preoperative and postoperative measurements ($P<0.001$). Mean TC and calcaneal pitch angles were measured as 42.1° (range 27-61°; SD: 10.53868) and 29.5° (range 23-37°; SD: 4.39644), respectively, at the last visit. At the last followup, there were 14 feet with TC angles more than 50°; out of the 14 feet, 8 had nonunion and 6 had inadequate correction. Although the increase in TC angles in the group with satisfactory outcome was not significant compared to controls, it was significant in the group with an unsatisfactory outcome ($P<0.05$) [Table 1].

Both feet of a patient (EHC) who had TC angles less than 30° at the last followup visit did not have any clinical heel varus, recurrent sprains, ulcers, callosities, or shoe wrecking in any of her feet. Also, she did not need orthotics for either of her feet.

The satisfactory fitting of the feet with orthotics was not possible preoperatively in any of them. The decrease in orthotic use was significant between preoperative and last followup visits ($P<0.05$). There was no need for orthotics in any of the feet in the group with satisfactory outcome. Satisfactory fitting of the orthotics was obtained in 14 feet of the group with an unsatisfactory outcome. Two feet in this group had skin ulcers due to failed orthotic treatment after surgery. Both feet were reoperated simultaneously taking the iliac graft from the contralateral side. Skin ulcers resolved after the reoperation.

There was no intraoperative complication other than a graft fall to the ground during operation in one patient. Postoperatively, three feet had superficial wound infections which resolved with local wound care. At final followup none patient had developed a Charcot joint or had an evidence of degenerative arthritis of the foot.

Discussion

The Grice Green procedure was designed to correct hind foot valgus deformity, restore the height of the foot, and preserve its subsequent growth.[17] If the procedure can not provide satisfactory outcome, it may still possible to provide a foot with improved alignment and stability with a triple arthrodesis at a later session.[19] In properly selected patients, the operation would likely be a definitive procedure, providing development toward normal maturity and allowing for function without pathologic subluxation. Later degenerative changes in the adjacent articular structures have been minimal and would appear to be no more marked than those seen following triple arthrodesis.[16] Grice subtalar blocking surgery preserves the height of the foot. Therefore, if further treatment is necessary after subtalar block, it is relatively easy to proceed with triple arthrodesis at the appropriate time.[16]

The Grice subtalar blocking surgery is appropriate in patients between 2 and 9 years of age.[20] After 8 years of age, most authors recommend triple arthrodesis.[17] There is also a debate for the lower age limit of this surgery.[2] The graft resorption and concomitant valgus deformity after surgery is more common in patients who underwent surgery at an earlier age in our series. Therefore, the age of the patient could be a factor in the cause of resorption and concomitant valgus deformity.

There are some other extraarticular subtalar arthrodesis

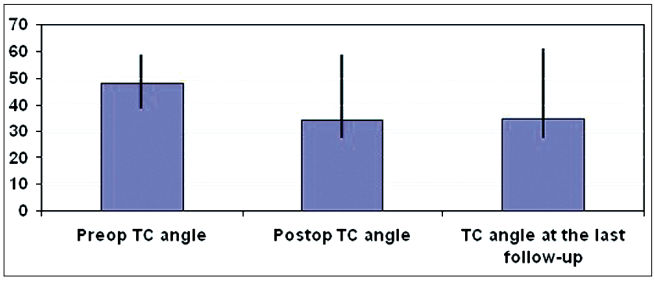

Figure 5: A bar diagram showing the preoperative, postoperative, and last followup talocalcaneal angle measurements

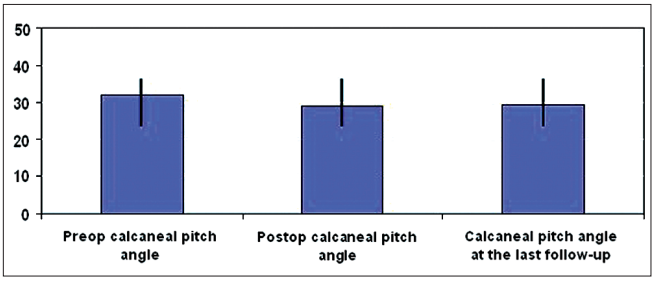

Figure 6: A bar diagram showing the preoperative, postoperative, and last followup calcaneal pitch angle measurements

Table 1: The preoperative, postoperative, and last followup talocalcaneal angles for groups with unsatisfactory and satisfactory outcome[a]

	Number	Mean age (months)	Preoperative talocalcaneal angle	Postoperative talocalcaneal angle	Talocalcaneal angle at the last followup
Group with satisfactory outcome	26	73.8	48.2°	34.1°	34.8°
Group with unsatisfactory outcome	16	57.7	48.9°	45.7°	54.0°

[a]The difference between preoperative and postoperative talocalcaneal angles was significant in the group with satisfactory outcome, whereas it was not significant in the group with unsatisfactory outcome

procedures described for correcting valgus feet.[7,9,10,14] Dennyson-Fulford technique is one of the most commonly known techniques. There are some disadvantages of this technique. The most common complications are due to internal fixation material, such as malpositioning of the screw, excessive penetration of lateral/plantar calcaneal cortex by using a long screw, and impingement of screw head over the anterior lip of distal tibia. Also, Hosny and Fabry reported avascular necrosis of the talus, after a Dennyson-Fulford subtalar arthrodesis technique[21] another commonly used modification is Batchelor technique which was reported by Brown in 1968.[9] However, this technique has the potential risk of converting the extraarticular arthrodesis into an intraarticular one, if the fibular peg is not driven through the sinus tarsi.[10] Furthermore, it produces a high pseudarthrosis rate due to the fracture of the graft, which cannot withstand shearing forces, especially if the axis of the graft is placed parallel to the axis of the subtalar joint.[8] Late ankle valgus deformity as a result of nonunion at the graft donor site has also been reported.[22-24]

The bone grafts may be obtained from fibula, tibia, or iliac crest. The late valgus deformity of the ankle may occur due to the failure of full regeneration when the graft is obtained from the ipsilateral fibula.[15,17] If a segment of the fibular diaphysis is removed in a growing child and does not regenerate, the tibiotalar joint frequently tilts into valgus position.[25] In the absence of a normally growing fibula, the lateral side of the tibial epiphysis grows slower than the medial side and valgus of the ankle results. The earlier in life the segment is removed, the more severe the valgus is seen.[25] When distal tibial shaft is used as a graft site, there may be an acceleration of the growth of the tibia at the donor site. This accelerated growth may increase the deformity or produce an ankle valgus.[26] As mentioned in a few series,[27] we took graft from iliac crest which has no such complications related to growth. Failure of fusion and resorption of the graft was reported in a certain percentage in all series except that of Tohen and Carrnona.[28] The incidence of resorption was approximately three times greater when homologous bone was used.[27] The fusion rates were higher in our series than in most series reported in the literature.[17,20,29]

One of the aims of this procedure was to provide reduction in orthotic use and to prevent the recurrent soft tissue ulcerations adjacent to the head of talus. In our series, reduction in orthotic device use was approximately the same as reported in literature.[6,26,29] Only two feet had skin ulcers due to failed orthotic treatment after surgery. Both feet were reoperated recently.

In the case of neuromuscular diseases, muscle balance can be restored by tendon transfers to avoid recurrence.[16] Some authors transfer the peroneus longus to the dorsum of the foot in addition to the subtalar fusion in equinovalgus feet.[16] A high incidence of dorsal bunions was found to be associated with this transfer, and later in the series, the peroneus brevis was substituted as a transfer to the dorsum of the foot in order to give dorsiflexion power to the equinovalgus feet. This particular type of transfer was implicated in other series as causing a late varus deformity.[1] We did not make tendon transfer in any of the feet, which can clarify the absence of dorsal bunion or late varus deformity in any of the feet.

Bratberg and Scheer[30] reviewed the literature on Grice Green subtalar arthrodesis for children and reported an overall success rate of 74% of 573 procedures. The results of the procedure for valgus deformity secondary to cerebral palsy have been encouraging.[15] Drvaric *et al*. reported 94% satisfactory results in their series and cited other studies with good or excellent results in 78–97%.[31] The results of Grice Green subtalar blocking surgery for children with spina bifida have been less encouraging. Ross and Lyne[17] operated 10 valgus feet with spina bifida. Eight out of 10 feet were reported as showing unsatisfactory result.[17] The complications reported in these series were ankle valgus (n=7), nonunion (n=1), delayed union (n=1), and slipped graft (n=2). Moreland and Westin operated seven valgus feet with spina bifida and four of them were considered as satisfactory.[6] McCall *et al*. reported graft failure in seven of nine feet and unsatisfactory results in all the feet.[32] Loss of correction in their series could be traced directly to slippage of the graft in 85% of patients with residual valgus. A result was also considered as unsatisfactory in those patients demonstrating significant ankle valgus postoperatively, since it was believed that instability merely had been transferred up from the hind foot to the ankle.

The most common primary complication reported has been varus due to overcorrection at the time of surgery or overcompensation with muscle-balancing procedures in paralytic feet. The valgus heel from inadequate correction or recurrence; and ankle instability are other common complications.[27] All authors agree that it is better to err on the site of slight valgus position of the heel at the time of operation than to overcorrect. Valgus is a position of stability and is preferable to any amount of varus.[16]

The failures are classified as early or late varus or valgus deformity of hind foot.[30] Early deformities are those which manifest during the first 6 postoperative months and late deformities are attributable to incomplete correction at the time of surgery. Late valgus is attributed to resorption of the graft. Early varus is due to overcorrection. Late varus, a

28% occurrence in the series of Aronson *et al*., was seen in neuromuscular disease when peroneus brevis and longus were transferred medially.[12] Varus deformity (early or late) was not seen in any of the feet in our series. However, we had 6 feet with early valgus due to inadequate correction and 10 feet with late valgus deformity due to graft resorption. Many authors noted incomplete fusions radiographically in patients with clinically stable and painless feet. The tendency for partial resorption in these grafts is certainly appreciated in light of the forces occurring in this region, the vascularity of the grafts, and the prolonged healing period for consolidation.

As a result, Grice subtalar blocking technique is still a valuable option for valgus foot in patients with spina bifida. In this study, we found more encouraging results in older patients. Even if unsatisfactory results are obtained after this technique, reduction in orthotic device use is seen and provides a foot with improved alignment and stability on which triple arthrodesis can be performed later.

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