

# Dorsal Bunion After Clubfoot Surgery

## Outcome of Reverse Jones Procedure

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**Background:** The dorsal bunion deformity consists of the elevation of first metatarsal head, plantar flexion contracture at the first metatarsophalangeal joint, and dorsiflexion contracture of the tarsometatarsal joint. A reverse Jones procedure with transfer of the flexor hallucis longus to the metatarsal head has been an effective method in correcting this deformity.

**Methods:** This is a retrospective review of 27 patients with 33 feet who had reverse Jones procedure with or without metatarsal osteotomy between 1983 and 2002. All patients had previous soft tissue releases for clubfoot deformity. Clinical reviews included muscle function test and radiographic evaluation before and after procedures. We used the American Orthopaedic Foot and Ankle Society Hallux Metatarsophalangeal-interphalangeal scale for functional outcome results.

**Results:** The average follow-up was 4.96 years. There were 21 boys and 6 girls. Average age at time of procedure was 13.7 years. With the reverse Jones procedure, there were 18 first metatarsal osteotomies and 12 split anterior tibial tendon transfers.

Before surgery, decreased muscle strength in triceps surae (73%), tibialis posterior (76%), peroneus longus (67%), and extensor hallucis longus (76%) was noted. Patients (84.9%) had normal tibialis anterior and flexor hallucis longus power.

In radiographic evaluations, the operation resulted in decreased elevation of the first metatarsal by measuring the metatarsal-horizontal angle. The lateral metatarsophalangeal angle improved from 23 degrees plantar flexion to 1 degree in dorsiflexion.

The average global American Orthopaedic Foot and Ankle Society Hallux Metatarsophalangeal-interphalangeal score was 70 preoperatively and 92 postoperatively with improvement of subscores in pain, activity, footwear, range of motion, callus, and alignment.

**Conclusions:** Dorsal bunion is a recognized long-term complication after clubfoot surgery. The causes of the deformity are weakness of Achilles tendon, overpowering of flexor hallucis longus, and strong anterior tibial tendon with weakness of peroneus longus. The reverse Jones procedure improved the condition in this series and provided a long-lasting and effective correction of the dorsal bunion deformity.

**Level of Evidence:** Level 4.

**Key Words:** clubfoot surgery, dorsal bunion, reverse Jones procedure, first metatarsal osteotomy

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Dorsal bunion is a deformity of the great toe consisting of first metatarsal head elevation, plantar flexion contracture at the first metatarsophalangeal joint, and dorsiflexion contracture at the tarsometatarsal joint (Fig. 1). Dorsal bunion can interfere with shoe wear or cause painful calluses. Lapidus<sup>1</sup> and Johnston and Roach<sup>2</sup> attributed the deformity to muscle imbalance between elevation and depression of the first metatarsal. Kuo<sup>3</sup> postulated that major factors leading to dorsal bunion after clubfoot surgery include weakness of the Achilles tendon, a strong overpowering flexor hallucis longus, forefoot supination with a strong anterior tibial tendon, and weakness of the peroneal longus tendon. The deformity presents most commonly after clubfoot treatment but can also be a sequela of various neuromuscular foot conditions, including poliomyelitis and cerebral palsy.<sup>1,4</sup>

To eliminate the shoe wear problem and painful callosities, a corrective procedure is necessary to correct the deformity and muscle imbalance. Since 1940, several procedures had been described for dorsal bunion deformity.<sup>1,3–7</sup>

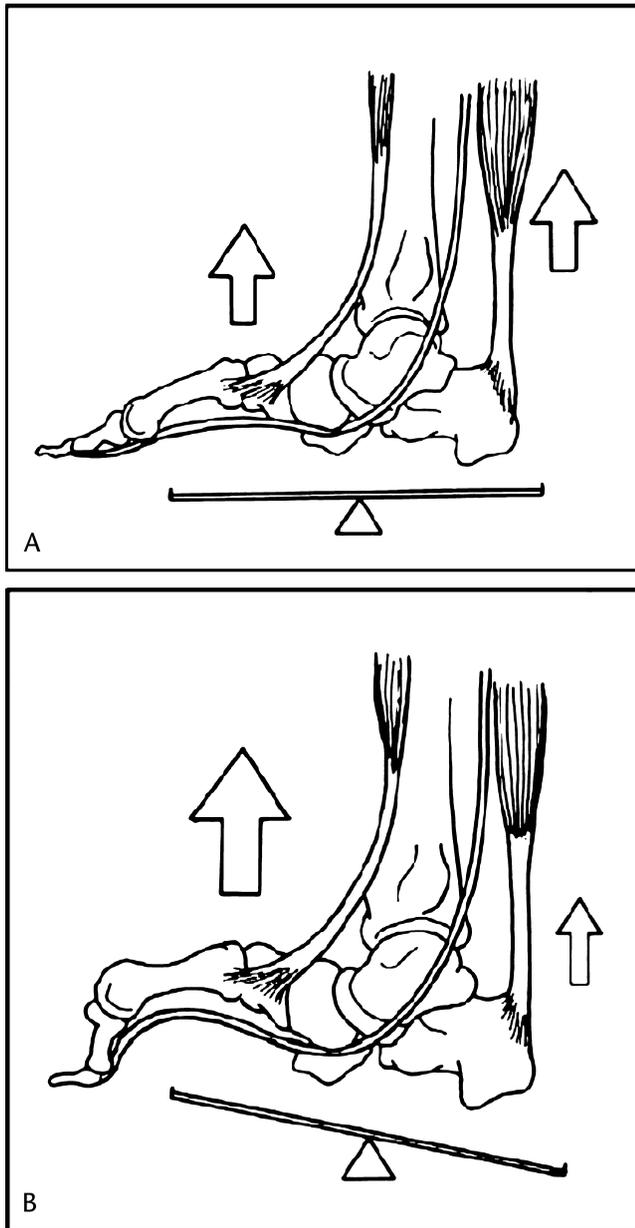
The purpose of this study is to evaluate the long-term outcome of the reverse Jones procedure (flexor hallucis longus tendon transfer) since 1983 at our institution.

### METHODS

Between 1983 and 2002, there were 40 patients with previous clubfoot release who developed a dorsal bunion deformity and had the reverse Jones procedure done at our hospital. Thirteen patients were excluded for less than 2 years' follow-up at our hospital or inadequate information in their record. Twenty-seven patients with 33 feet were reviewed retrospectively.

The complete clinical records were reviewed, including sex, side of involvement, previous treatments, age of surgeries, concomitant procedures, and subsequent surgeries. Muscle power evaluations of all patients were recorded preoperatively using the Jones classification.

Preoperative radiographs and those done at last follow-up were available. All radiographs were taken in standing anteroposterior (AP) and lateral views. The angles measured include the AP and lateral talocalcaneal angles—the angle of the first metatarsal axis with the horizontal plane of the ground and first metatarsal-proximal phalangeal angle in lateral view. The angle of the first metatarsal axis to the horizontal plane of the ground measures the inclination of the first metatarsal. The measurements here were made on a standing lateral radiograph in which the tibia was at a right angle to the ground and there was no fixed equinus of the foot.



**FIGURE 1.** A, Normal foot showed balance of muscle pulling. B, The drawing showed weak Achilles tendon function with compensation of flexor hallucis longus function and overpulling of anterior tibial tendon. It causes flexion deformity of the first metatarsophalangeal joint, and elevation of metatarsal head resulted in dorsal bunion.

The outcome rating system used was the American Orthopaedic Foot and Ankle Society (AOFAS) Hallux Metatarsophalangeal-interphalangeal scale with total score of 100 points as the best result (Table 1).

The differences in preoperative and postoperative values were analyzed using a paired Student *t* test. This test determines the probability whether 2 samples are likely to have come from the same 2 underlying populations that have the same mean.  $P < 0.05$  was considered a significant difference.

### Reverse Jones Procedure

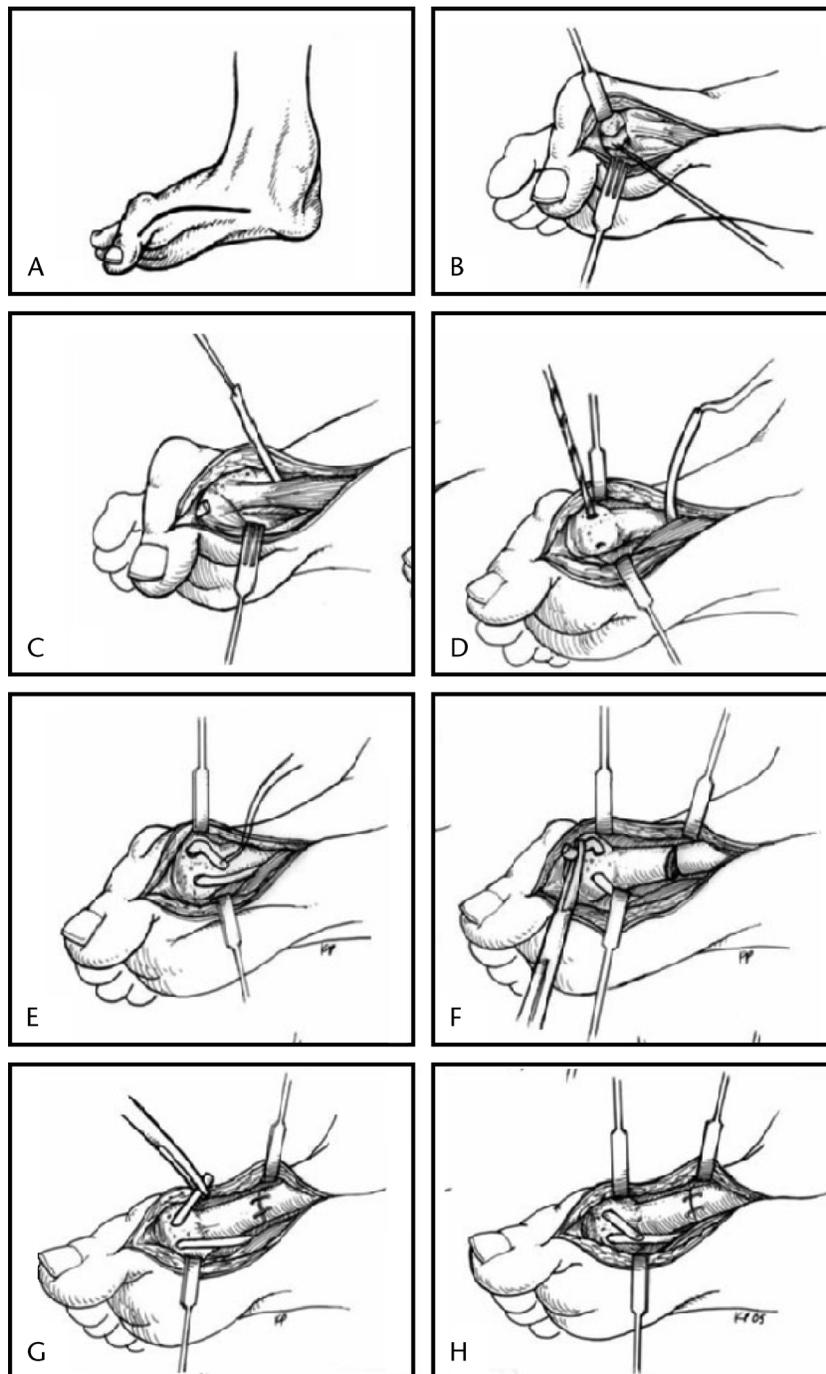
A longitudinal incision is made at the medial aspect of the foot starting at the medial cuneiform bone and extending distally to the first metatarsal head. The flexor hallucis longus is identified and divided distal to the metatarsophalangeal joint and delivered into the proximal part of the wound. A tunnel is drilled at the junction of the neck and head of the first metatarsal from its dorsal to its plantar aspect. The distal end of flexor hallucis longus tendon is brought from the plantar to dorsal aspect through the tunnel in the first metatarsal and turned back sutured to itself with first metatarsal in plantar flexion. The flexor hallucis longus now functions as a plantar flexor of the first metatarsal (Figs. 2A–E).

If the first ray cannot be easily brought to a neutral position, a plantar flexion osteotomy of the first metatarsal is performed (Figs. 2F–H). In cases where forefoot supination and anterior tibial tendon are felt to be a contributing factor for dorsal bunion, a split anterior tibial

**TABLE 1.** AOFAS Hallux Metatarsophalangeal-Interphalangeal Rating Scale

Pain (40 points)	
None	40
Mild, occasional	30
Moderate, daily	20
Severe, almost always present	0
Function (45 points)	
Activity limitations	
No limitations	10
No limitation of daily activities such as employment responsibilities and limitation of recreational activities	7
Limited daily and recreational activities	4
Severe limitation of daily and recreational activities	0
Footwear requirements	
Fashionable, conventional shoes, no insert required	10
Comfort footwear, shoe insert	5
Modified shoes or brace	0
MTP joint motion (dorsiflexion and plantarflexion)	
Normal or mild restriction ( $\geq 75$ degrees)	10
Moderate restriction (30-70 degrees)	5
Severe restriction ( $< 30$ degrees)	0
IP joint motion (plantarflexion)	
No restriction	5
Severe restriction	0
MTP-IP stability (all directions)	
Stable	5
Definitely unstable or able to dislocate	0
Callus related to hallux MTP-IP	
No callus or asymptomatic callus	5
Callus, symptomatic	0
Alignment (15 points)	
Good, hallux well aligned	15
Fair, some degree of hallux malalignment observed, asymptomatic	8
Poor, obvious symptomatic malalignment	0

IP indicates intraperitoneal; MTP, metatarsophalangeal.



**FIGURE 2.** Reverse Jones procedure. A, Skin incision. B, Flexor hallucis longus tendon isolated. C, Tendon divided and delivered proximally; D, A drill hole is made in dorsal-plantar direction through first metatarsal head. E, The tendon is passed from plantar toward dorsal through the drill hole. F, Proximal metatarsal flexion osteotomy when needed. G, The osteotomy is internally fixed. H, The end of the tendon is sutured back to itself with metatarsal in flexion position.

tendon transfer is performed moving lateral arm of the transfer to the cuboid.<sup>8</sup>

### RESULTS

The average follow-up was 4.96 years (range, 2–10.9 years). There were 21 boys (78%) and 6 girls

(22%). Seventeen patients had bilateral clubfeet, 8 involving only the right foot and 2 only the left. Of these 27, 13 had dorsal bunions involving the right foot, 8 on the left, and 6 bilateral. The average age at time of dorsal bunion operation was 13.7 years, with a range of 3.8 to 21 years.

**TABLE 2.** Muscle Power Function Before Procedure by Jones Classification

Muscle	Normal Power (Grade 5) (%)	Grade 4 or Less (%)
Triceps surae	27	73
Tibialis posterior	24	76
Peroneus longus	33	67
Extensor hallucis longus	24	76
Tibialis anterior	85	15
Flexor hallucis longus	85	15

Concomitant procedures performed at the time of the reverse Jones procedure were 18 first metatarsal osteotomies (55%), 12 split anterior tibial tendon transfers (37%), 3 triple arthrodeses (9%), 1 calcaneal osteotomy (1 case), and 1 metatarsophalangeal joint fusion (1 case).

There was an average of 2.2 previous clubfoot surgeries (range, 1–8 surgeries) per patient. All had had lengthening of the Achilles tendon. All except 1 patient had lengthening or release of the tibialis posterior tendon. All but 1 patient had serial casting for initial clubfoot treatment. The average duration of casting was 5.6 months. The duration between the last clubfoot surgery and dorsal bunion surgery ranged from 1 to 20.6 years, with an average of 9.7 years.

Muscle power evaluation by Jones classification before the procedure was available. The following groups of muscle had power of grade 4 or less: triceps surae (73%), tibialis posterior (76%), peroneus longus (67%), and extensor hallucis longus (76%). Patients (84.9%) had normal tibialis anterior and flexor hallucis longus power (Table 2).

In radiographic evaluation, the average AP measurement of the talocalcaneal angle was 21 degrees preoperatively and 21 degrees postoperatively. The lateral talocalcaneal measured 23 degrees preoperatively and 23 degrees postoperatively. There was no significant difference in the measurement before and after the procedure.

The average angle of the first metatarsal axis to the horizontal plane of the ground was 9 degrees in plantar flexion before the surgery and 18 degrees in plantar flexion after the surgery. The mean difference before and after surgery was 9 degrees. The operation resulted in significantly more plantar flexion of the first metatarsal; therefore, the metatarsal head became less prominent dorsally ( $P < 0.05$ ) (Fig. 3). When we looked at osteotomy group versus

**TABLE 3.** Radiographic Measurement Before and After Operation

Angles	Preoperative (Degrees)	Postoperative (Degrees)	t test P
AP talocalcaneal	21	21	>0.05
Lateral talocalcaneal	23	23	>0.05
First metatarsal axis to the horizontal plane of the ground	9 (plantar)	19 (plantar)	<0.001
Lateral metatarsophalangeal	23 (plantar)	1 (dorsal)	<0.01

$P < 0.05$  is significant.

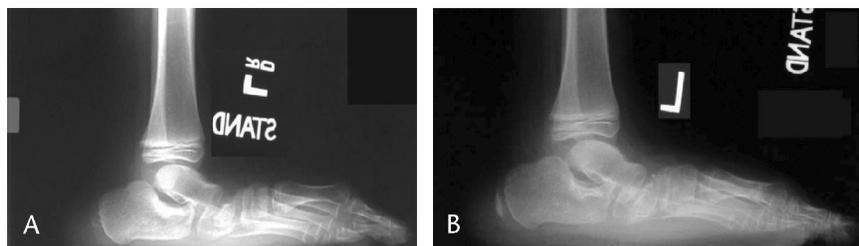
nonosteotomy group, in the group with osteotomy, this average angle was 9 degrees before surgery and 20 degrees after surgery, whereas in the group without osteotomy, it was 9 and 17 degrees, respectively.

The average lateral metatarsophalangeal angle was 23 degrees in plantar flexion preoperatively and 1 degree in dorsiflexion after the operation, an improvement of 24 degrees ( $P < 0.05$ ) (Table 3). When we looked at osteotomy group versus nonosteotomy group, in the group with osteotomy, the angle was 25 degrees in plantar flexion before surgery and 3 degrees in dorsiflexion after surgery, whereas in the group without osteotomy, it was 19 and 2 degrees, both in plantar flexion, respectively.

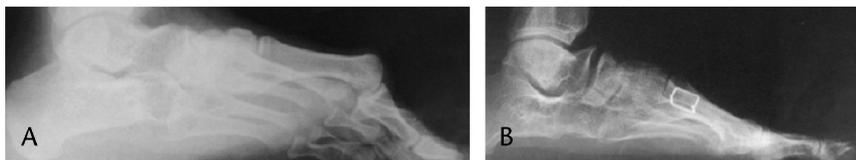
Of 33 feet, 18 had plantar flexion osteotomy at the base of the first metatarsus (Fig. 4); none had any recurrence. The remaining 15 feet did not have osteotomy of the first metatarsal at the time of the reverse Jones procedure. Of these, 5 feet required the osteotomy later due to recurrence of the deformity; among them, 4 were older than 10 years. The subsequent results of these revisions were satisfactory.

There was no complication except for 1 case with a prominent screw head that was subsequently removed. At final follow-up, 61% of the forefeet were in supination, 21% in pronation, and 18% in neutral position.

The average global AOFAS Hallux Metatarsophalangeal-interphalangeal score before the reverse Jones procedure was 70 (range, 55–90) and 92 postoperatively (range, 65–100) (Fig. 5). The mean preoperative pain subscore was 31.5 and 38.2 postoperatively, an improvement of 6.7 points. There was also a slight increase in the postoperative activity subscore from 8.9 to 9.6. There was improvement in footwear



**FIGURE 3.** A foot with reverse Jones transfer. A, Preoperative lateral standing radiograph. B, Postoperative radiograph showed good correction of dorsal bunion.



**FIGURE 4.** A foot with reverse Jones transfer and proximal first metatarsal osteotomy. A, Preoperative lateral standing radiograph. B, Postoperative radiograph showed good correction of dorsal bunion.

from 6.1 to 8.6 points after the reverse Jones procedure. The subscore for the range of movement of the metatarsophalangeal improved from 7.0 to 8.8 points. There was no limitation in the range of movement of the interphalangeal joint before and after the surgery. The stability of the metatarsophalangeal joint was also noted to be unchanged. The average subscore for callus related to the bunion improved from 3.6 to 4.9. There was an improvement in the alignment with an average subscore of 2.9 preoperatively to 11.7 postoperatively (Table 4).

### DISCUSSION

Lapidus<sup>1</sup> suggested a few possible mechanisms for the development of dorsal bunion in paralytic condition and clubfoot. He suggested that the most common mechanism was combined weakness of the peronei with a strong tibialis anterior and great toe flexors, which might lead to the deformity. Supination or varus position of the foot deprives the forefoot of its medial weight-bearing point beneath the sesamoid bone of the great toe. The strong tibialis anterior brings the first metatarsal into dorsiflexion especially because it is not opposed by the peroneus longus, which is a plantar flexor of the first metatarsal. The patient will use the great toe flexor to create a medial weight-bearing point. A second group of patients have weak dorsiflexors of the foot and toes with strong plantar flexors of the great toe and calf muscles. The plantar flexors of the toe prevail, being unopposed by the dorsiflexors. The base of the proximal phalanx subluxates plantarward under the head of the first metatarsal and pushes the latter dorsally, causing dorsiflexion of the first metatarsal, and a dorsal bunion is formed. The third group exhibits calcaneus deformity from gastrosoleus weakness and uses the flexor hallucis longus as an accessory plantar flexor of the foot.

Goldner<sup>4</sup> found paralysis or transfer of extensor hallucis longus in conjunction with talipes equinovarus or

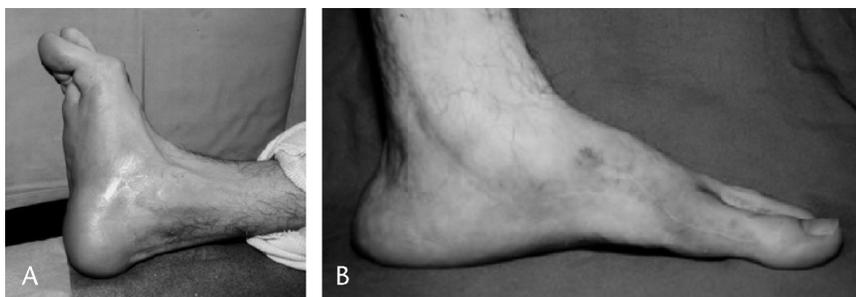
talipes equinovarus, with contracture of the flexor brevis and flexor hallucis longus and overaction of the tibialis anterior, to be a major cause of the deformity. He did not identify the absence of the peroneus longus in feet with cerebral palsy or paralytic condition.

In McKay's<sup>6</sup> study, 10 of 11 patients who developed dorsal bunion after clubfoot surgery had a weak triceps surae. Dorsal bunion develops as the patient tries to push off using the toe flexors to compensate for the triceps surae weakness. In addition, 8 of 11 had a weak or nonfunctioning peroneus longus, and 9 had a weak flexor hallucis longus. McKay felt the primary deformity was the flexor hallucis brevis.

Johnston and Roach<sup>2</sup> found that there is an imbalance between elevation (tibialis anterior) and depression (peroneus longus) of the first metatarsal and between the great toe flexors and extensors. This leads to the deformity where the metatarsal head is prominent dorsally (bunion), with the great toe sharply flexed at the metatarsophalangeal joint.

Kuo<sup>3</sup> postulated that major factors leading to dorsal bunion after clubfoot surgery include weakness of the Achilles tendon, a strong overpowering flexor hallucis longus, forefoot supination with a strong anterior tibial tendon, and weakness of the peroneus longus tendon. There were 9 patients with 11 feet in the study. The initial series showed that the reverse Jones procedure with or without metatarsal plantar flexion osteotomy and with or without split anterior tibial tendon transfer is an excellent procedure for correction of the dorsal bunion deformity resulting from clubfoot soft tissue releases.

Smith and Kuo<sup>9</sup> reiterated that dorsal bunion can result from aggressive soft tissue releases for clubfoot deformities. Overlengthening of the Achilles tendon will eventually lead to irreparable weakening of plantar flexion function. To obtain good push-off strength, the toe flexors often supplement for the weakened Achilles tendon. The overstretched peroneus longus tendon in the original clubfoot deformity may not return to



**FIGURE 5.** A 17-year-old boy with dorsal bunion with previous soft tissue releases. A, The picture at operation table showed obvious bunion deformity. B, A year after surgery, the standing picture showed excellent correction.

**TABLE 4.** AOFAS Metatarsophalangeal Scores Before and After Operation

AOFAS score (points)	Preoperative Points	Postoperative Points	t test P
Global (maximum, 100)	70	91.8	<0.01
Pain (maximum, 40)	31.5	38.2	<0.01
Activity (maximum, 10)	8.9	9.6	<0.05
Footwear requirements (maximum, 10)	6.1	8.6	<0.001
Metatarsophalangeal joint motion (maximum, 10)	7.0	8.8	<0.003
Interphalangeal joint motion (maximum, 5)	5	5	No difference
Metatarsophalangeal-interphalangeal joint stability (maximum, 5)	5	5	No difference
Callus related to bunion (maximum, 5)	3.6	4.9	<0.05
Alignment (maximum, 15)	2.9	11.7	<0.0001

P < 0.05 is significant.

normal strength after correction of the deformity or may be damaged during clubfoot releases. This results in imbalance between elevation and depression of the first metatarsal as the tibialis anterior tendon function remains normal.

In 1940, Lapidus<sup>1</sup> described a procedure for patients with poliomyelitis that combined arthrodesis of the first metatarsal cuneiform joint, capsulorrhaphy of the first metatarsophalangeal joint, transfer of the flexor hallucis longus to the distal end of the first metatarsal, and the tibialis anterior tendon posteriorly to the tibialis posterior tendon. He stressed that correction of the faulty first metatarsal position is important when correcting the dorsal bunion deformity. He performed this procedure in 6 patients between 1932 and 1939 with encouraging results.

Hammond<sup>5</sup> described a procedure using a cortical bone graft for a first metatarsal cuneiform joint arthrodesis. The insertion of the tibialis anterior is transferred to the middle of the foot without transferring the flexor hallucis longus. McKay<sup>6</sup> suggested the transfer of flexor hallucis brevis to the first metatarsal head to produce plantar flexion of the metatarsal. The interphalangeal joint is arthrodesed.<sup>6</sup>

In his textbook, Tachdjian<sup>7</sup> described the technique of flexion osteotomy at the base of the first metatarsal bone with transfer of the flexor hallucis longus to the metatarsal head. Kuo<sup>3</sup> first used the term “reverse Jones procedure” for flexor hallucis longus transfer to the first metatarsal head at the First International Clubfoot Congress in 1990.

Our indications of surgery are symptomatic dorsal bunions, including shoe wear problems, callosity, and pain. The timing of the surgery depends on the child’s symptoms. However, most of the bunions were observed in older patients.

In the current study, we found that 73% of the patients have weakness of the calf muscles, 67% the peroneus longus, and 76% the extensor hallucis longus. Patients (85%) have a strong tibialis anterior and flexor hallucis longus. Most had the toe flexor used as an important plantar flexor of the foot to compensate for the weakness of the calf muscles. In addition, weakness of the peroneus longus, which is a depressor of the first metatarsal, and a strong tibialis anterior, which is a dorsiflexor of the first metatarsal, further aggravate the deformity. In this series of patients, there was no evidence that the peroneus longus had been lengthened or damaged in previous surgery. Most patients in this study had forefoot

supination. Plantar flexion of the great toe may be required to establish adequate medial weight bearing.

The angle of the first metatarsal axis to the horizontal plane of the ground improved to a more plantar flexed position after the reverse Jones procedure. Flexor hallucis longus acts as a depressor of the first metatarsal after the transfer, therefore reducing the prominence of the first metatarsal head. If there is any stiffness of plantar flexion of the tarsal first metatarsal joint, a first metatarsal plantar flexion osteotomy should be performed. This combination is very effective because none of the 18 patients who had both procedures performed developed a recurrence. Of 15 patients who did not have a plantar flexion osteotomy, 5 had recurrence of deformity and needed a secondary procedure, suggesting that most patients require this as a primary procedure. We now recommend considering osteotomy in those patients older than 10 years.

The AOFAS score showed that there is a substantial improvement in the correction of the deformity after the reverse Jones procedure. This has also led to improvement in skin conditions related to the deformity such as symptomatic callus.

**CONCLUSIONS**

Dorsal bunion is a recognized long-term complication after clubfoot surgery. The causes of the deformity can be 1 or any combination of the following factors: weakness of Achilles tendon, overpowering of flexor hallucis, and strong anterior tibial tendon with weakness of peroneus longus. The patient often has weakness of the triceps surae due to overcorrection from clubfoot releases. The flexor hallucis longus compensates for gastrocnemius weakness for push off. This results in a flexed great toe and a prominent first metatarsal head. We describe a reverse Jones procedure that consists of transferring the flexor hallucis longus to the first metatarsal head with metatarsal plantar flexion osteotomy when indicated. The procedure provides a lasting and effective correction of the dorsal bunion deformity.

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