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Single-event Multilevel Acute Total Correction of Complex Equinocavovarus Deformity in Skeletally Mature Patients with Spastic Cerebral Palsy Hemiparesis

Sherif N.G. Bishay, MD, FRCS (England)

Assistant Professor, Department of Orthopaedics, National Institute of Neuromotor System, Imbaba, Giza, Egypt

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ABSTRACT

Complex multiplanar ankle/foot deformity as equinocavovarus is a common problem in patients with spastic cerebral palsy hemiparesis. The data from 30 consecutive patients (30 feet), treated between March 2009 and March 2010, with equinocavovarus and toe clawing secondary to spastic cerebral palsy hemiparesis, aged 16 to 18 years, were analyzed clinically and radiographically. All the patients had received conservative physiotherapy treatment and ankle/foot orthoses before undergoing combined soft tissue and bony surgical procedures performed in a single session to correct the complex toe clawing, cavus, varus, and equinus deformities. Preoperative measurements of certain foot angles were compared with their corresponding postoperative values. A grading system for evaluation of the results using a point scoring system was used to accurately evaluate both the clinical and the radiographic results after an average follow-up period of 2.5 years. Of the 30 patients (30 feet), 18 (60%) had excellent, 9 (30%) good, 3 (10%) fair, and 0 had poor outcomes. Neither vascular problems nor nonunion occurred. Significant improvement was seen postoperatively ($p < .0333$). Neither staged surgical procedures nor gradual distraction techniques using external fixators are ideal modalities to correct complex ankle/foot equinocavovarus deformity in patients with spastic cerebral palsy. Single-event, multilevel surgery with complete soft tissue and bony correction appears to be the treatment of choice in such cases. It shortens the treatment period and avoids patient dissatisfaction associated with multiple procedures, without major complications.

Complex multiplanar ankle/foot deformity as equinocavovarus is a common disabling problem in patients with spastic cerebral palsy (CP) hemiparesis, deforming the foot in both the sagittal (equinus and cavus) and the transverse (varus) planes (1).

Staged surgical procedures to correct soft tissue and bony deformities are not ideal modalities for patients with spastic CP. Single-session surgery should be the treatment of choice in such cases (2).

Gradual distraction techniques using external fixators are not tolerated in patients with spastic CP, either physically or psychologically (3).

The objective of the present study was to determine the effectiveness of acute total correction of soft tissue and bony complex ankle/foot deformity in patients with spastic CP hemiparesis in obtaining a painless stable plantigrade foot without short- or long-term vascular problems and with a short hospital stay and rehabilitation period.

Patients and Methods

A review was done of the data from a group of 30 consecutive adolescents with CP hemiparesis, who had presented to the National Institute of Neuromotor System from March 2009 to March 2010 with neglected ankle/foot deformity and had undergone surgical treatment. The results from this group after at least 2 years of follow-up were recorded in March 2012 using the medical records, history, and physical and imaging examination findings. The study fulfilled the Egyptian ethics code of research.

The inclusion criterion was neglected, fixed (nonmobile) equinocavovarus deformity in ambulatory adolescents aged 16 to 18 years with spastic CP hemiparesis. Excluded from the present study were patients with congenital, traumatic, or infective foot disorders, those without CP, those with nonhemiparesis CP, nonambulatory patients, and those with other associated foot tendon injuries.

Preoperative Clinical Evaluation, Original Disease, and Treatment

A neurologic examination was done to exclude those without CP or hemiparesis. The assessment included evaluation of the muscle tone, motor power, sensation, reflex activity, and gait.

The orthopedic examination included the gait, the presence of deformities, the components of the ankle/foot deformity, range of motion, and skin condition.

All 30 patients were hemiplegic. No patient was diplegic or had total body involvement. All were able to walk without support and were considered to be community level ambulatory. The mean age at surgery was 16.9 (range 16 to 18) years. Of the 30 patients (30 feet), 15 were males and 15 were females. The right ankle/foot was affected in 16 patients (i.e., right-sided hemiparesis), of whom 10 were males and 6 were females. The left ankle/foot was affected in 14 patients (i.e., left-sided

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Address correspondence to: Sherif N.G. Bishay, MD, FRCS (England), Department of Orthopaedics, National Institute of Neuromotor System, 51 Al-Madina Al-Menawara Street, Al-Mouhandeseen, Imbaba, Giza 12411, Egypt.
E-mail address: snbishai@hotmail.com

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hemiparesis), of whom 5 were males and 9 were females (Table 1). All the feet had fixed clawing, cavus, and hindfoot varus deformities, as assessed by Coleman's block test (4), with callosities over the dorsolateral aspect and under the first metatarsal heads. All the ankles had fixed equinus deformity.

All the patients had undergone some form of nonoperative physical therapy and ankle/foot orthoses but had not undergone any form of surgery in the extremities.

Preoperative Radiographic Evaluation

Weightbearing anteroposterior and lateral radiographic views of the ankles and feet were taken of all the patients (5). On the anteroposterior view of the foot, the anterior talocalcaneal angle (TCA1) or Kite's angle (normal 20° to 40°) (6), anterior talo-first metatarsal angle (TFMA1) (normal 0° to −10°, adduction positive) (6), and calcaneo-fifth metatarsal angle (CFMA) (normal 0° to 5°) (7) were measured. On the lateral view of the foot, the lateral tibiocalcaneal angle (normal 55° to 95°) (8), lateral talocalcaneal angle (TCA2) (normal 25° to 50°) (6), and lateral talo-first metatarsal angle or Meary's angle (TFMA2) (normal 0° to 5°) (6) were measured. The variable range of these weightbearing radiographic angles was recorded and the mean calculated. The preoperative mean TCA1 was 15° (range 5° to 24°), mean TFMA1 was 34° (range 14° to 68°), mean CFMA 18° (range 15° to 27°), mean lateral tibiocalcaneal angle was 114° (range 100° to 120°), mean TCA2 was 14° (range 0° to 32°), and mean TFMA2 was 16° (range 0° to 40°).

Surgical Procedures

All 30 feet underwent multilevel soft tissue and bony surgery in a single session. The operative procedures were performed in the following order: soft tissue procedures, including Achilles tendon lengthening, Steindler's plantar fasciotomy, and modified Jones' extensor hallucis longus tendon transfer through the first metatarsal neck; and bony procedures, including dorsal wedge osteotomy of the base of the first metatarsal and calcaneocuboid, talonavicular, and subtalar fusion (triple arthrodesis).

Soft Tissue Procedures

Achilles tendon lengthening was performed through a posteromedial incision along the distal leg to expose the posterior aspect of the tendon. A small segment of the plantaris tendon was excised, if present. The tendon was then cut in the sagittal plane in a Z-plasty fashion, coming out medially in the distal tendon, to eliminate its inversion pull, and laterally in the proximal tendon. The ankle was dorsiflexed to the neutral plantigrade position, and the tendon was sutured under maximal tension, which was obtained using an Allis' forceps on both its limbs (9).

Next, Steindler's plantar fasciotomy was performed. Through a longitudinal incision along the medial border of the foot, the plantar aponeurosis was exposed and stripped from its calcanean attachment using a McDonald dissector to avoid injury to the calcanean vasculature (10).

Finally, a modified Jones' extensor hallucis longus tendon transfer through the first metatarsal neck was performed. Through a longitudinal dorsomedial incision along the great toe and the forefoot, the extensor hallucis longus and brevis tendons were exposed and sutured together using 0-1 Prolene suture as distally as possible. The extensor hallucis longus tendon was divided just proximal to the 2 sutured tendons, leaving its distal stump sutured to the extensor hallucis brevis tendon. These together formed a new, long, extensor tendon of the great toe interphalangeal joint to prevent later great toe drop and great toe interphalangeal joint fusion. Pull-through criss-cross (zigzag) sutures were placed in the free end of the extensor hallucis longus tendon. A hole was drilled through the neck of the first metatarsal using a 3.2 drill bit, through which the free end of the extensor hallucis longus tendon was passed using its sutures, immediately after the first metatarsal base osteotomy, and sutured on itself under strong tension using no. 1 Ethibond sutures (Ethicon, Johnson & Johnson Inc, Somerville, NJ), with the first metatarsal shaft forcibly elevated dorsally (11).

Table 1
Patient data (N = 30 lower extremities in 30 patients)

Variable	Value
Age (y)	16–18
Gender (n)	
Boys	15
Girls	15
Side (n)	
Right (right-sided hemiparesis)	16
Boys	10
Girls	6
Left (left-sided hemiparesis)	14
Boys	5
Girls	9
Total (n)	
Patients	30
Feet	30

Bony Procedures

The dorsal wedge osteotomy of the base of the first metatarsal was performed through the previous dorsomedial incision of the forefoot. The base of the first metatarsal was exposed subperiosteally, and an appropriate dorsally based wedge was resected, immediately before passage of the extensor hallucis longus tendon through the drilled hole of the first metatarsal neck. This was done to completely correct the dropped first metatarsal of the clawing and cavus foot (12).

Finally, triple arthrodesis (calcaneocuboid, talonavicular, and subtalar fusion) was performed. Through an anterolateral (Kocher's) incision, starting just lateral and distal to the head of the talus and curving beneath and behind the lateral malleolus, appropriate dorsolaterally based wedges were resected from the midtarsal (calcaneocuboid and talonavicular) and subtalar joints. The raw joint surfaces were secured together using staples to completely correct the varus foot and equines deformities (13).

A plantigrade foot position was obtained. The skin was sutured in all 4 wounds with 0-3 white Vicryl subcuticular sutures.

Postoperative Care

A well-padded, non-weightbearing, above the knee plaster of Paris cast was applied in all feet. It was advisable to split the cast in the immediate postoperative period to avoid the complications of edema. The sutures were removed at 4 weeks,

Table 2
Scoring system

Variable	Score
Clinical evaluation (10 points)	
Claw toe deformity (2 points)	
Full correction (no clawing)	2
Partial correction	1
No correction	0
Cavus (2 points)	
Full correction	2
Forefoot drop <20°	1
Forefoot drop >20°	0
Hindfoot varus (2 points)	
Full correction	2
Partial correction (varus <20°)	1
Varus >20°	0
Ankle equinus (2 points)	
Full correction	2
Partial correction (equinus <20°)	1
Equinus >20°	0
Tolerability of orthosis (1 point)	
Tolerable	1
Intolerable	0
Patient/parent satisfaction (1 point)	
Satisfied	1
Unsatisfied	0
Radiographic evaluation (10 points)	
Anterior talocalcaneal angle (1 point)	
20°–40°	1
<20°	0
Anterior talo-first metatarsal angle (2 points)	
<10°	2
10°–20°	1
>20°	0
Calcaneo-fifth metatarsal angle (1 point)	
<10°	1
>20°	0
Lateral tibiocalcaneal angle (2 points)	
<60°	2
60°–90°	1
>90°	0
Lateral talocalcaneal angle (2 points)	
20°–50°	2
10°–<20°	1
<10°	0
Lateral talo-first metatarsal angle (2 points)	
10°–20°	2
>20°	1
<10°	0
Total score (20 points)	
Excellent	19–20
Good	16–18
Fair	10–15
Poor	<10