

TRIPLE ARTHRODESIS FOR CHILDREN WITH SPASTIC CEREBRAL PALSY

*M. Lloyd Ireland
Mark Hoffer*

Management of foot deformities of children with spastic cerebral palsy is aimed at obtaining and maintaining a balanced plantigrade foot. Bracing, with adjunct tendon release, lengthening and/or transfers, is often necessary. Triple arthrodesis is a consideration for correction of hindfoot deformity and relief of pain, usually in the pre- and post-pubertal age groups. Two previous reports suggest that triple arthrodesis provides excellent correction of deformity and improved stability for ambulatory patients with cerebral palsy (Horstmann 1977, Malekafzali and Rosenthal 1981).

A review was done of 20 patients with spastic cerebral palsy who underwent 25 triple arthrodeses from 1968 to 1982 on the Children's Service at Rancho Los Amigos Hospital. The indications for surgery were to improve gait and orthotic use in adolescent patients with fixed bony deformity and to relieve hindfoot pain.

Material and method

All 20 patients (12 male, eight female) were examined at follow-up by one or both of the authors. The etiology of the cerebral palsy was congenital in 14 patients and head trauma sustained at less than age 10 in the remaining six. Nine right, six left and five bilateral triple arthrodeses had been performed. The average age at time of

surgery was 15 years 6 months, with the range from 11 years 8 months to 33 years 6 months. If the oldest patient was omitted, the average drops to 14 years 7 months. Six patients had diplegia, seven hemiplegia, five had total body involvement, and two had triplegia. Preoperative hindfoot deformities were five equinovarus, six equinovalgus, 13 valgus and one calcaneovalgus. All patients were spastic, except for one with athetosis and one with mixed athetoid spastic components. Indications for the triple arthrodesis were pain in five feet and deformity in the other 20. All of the bilateral procedures were performed to improve deformity.

The average follow-up was 4½ years, with a range from one to 15 years. The patients were evaluated clinically for position of the hindfoot, stability of the fusion and observation of gait, and radiographically for fusion rates and other foot abnormalities, including degenerative joint disease. Follow-up X-rays were obtainable for 18 feet (15 patients).

Previous treatment

Soft-tissue procedures had been performed on 11 ipsilateral feet (10 patients) prior to the triple arthrodesis (Table I). Tendo-achilles lengthening was done as a single or combined procedure for five feet, and the posterior tibialis was transferred or

TABLE I
Surgery performed before triple arthrodesis

Procedure	N feet
Single	
Tendo-achilles lengthening	3
Gastrocnemius lengthening	1
Posterior tibialis transfer	1
Combined	
Tendo-achilles lengthening, posterior tibialis release, split anterior tibialis transfer	1
Posterior tibialis lengthening, gastrocnemius lengthening	2
Posterior tibialis transfer, tendo-achilles lengthening	1
Multiple	
Soft-tissue procedures and subtalar fusion	1
Soft-tissue procedures and calcaneal osteotomy	1

TABLE II
Soft-tissue surgery done with triple arthrodesis

Procedure	N feet
Peroneus brevis release	3
Tendo-achilles lengthening	1
Tendo-achilles lengthening, posterior brevis and longus release	1
Tendo-achilles lengthening, release of posterior tibialis, flexor hallucis longus, flexor digitorum longus	1
Transfer peroneus brevis to achilles, release anterior ankle capsule	1

lengthened in another five. Multiple soft-tissue surgeries and bony procedures had been done on two feet (two patients) before the triple arthrodesis. 14 feet (10 patients) had not undergone previous surgery.

Ipsilateral soft-tissue procedures were performed at the time of fusion in six patients (seven feet). The most common combined surgeries were peroneus brevis releases in four feet (Table II); these were done if the ankle tended to remain in valgus after the patient was under general anesthesia. Tendo-achilles lengthening was performed based on preoperative gait assessment, tightness after induction, general anesthesia, and the activity of gastrosoleus complex in EMG studies. Multiple soft-tissue procedures were necessary for three feet. Several patients also had knee and hip soft-tissue releases at the same time as the triple arthrodesis.

There were no ipsilateral soft-tissue procedures on 18 feet (14 patients) when the fusion was done.

Ambulation and orthoses

Eighteen patients were ambulatory before the triple arthrodesis. The other two patients were non-functional ambulators and the surgery was done in the hope that they might resume ambulation. 13 of the 20 patients were dependent on braces before surgery, and they all had skin problems involving pressure breakdown, ulcers and calluses. Positioning was especially difficult for the patient with the valgus foot in polypropylene or metal ankle-foot orthoses.

Surgical technique

A standard triple arthrodesis was performed, with excision of excess bony wedges based on the clinical deformity. Generally the soft-tissue releases were performed first, then the triple arthrodesis. Using the standard incision, an oblique lateral approach was used. The extensor brevis was sharply reflected off the calcaneus distally. The sinus tarsi was cleared of fat to expose the subtalar and calcaneal cuboid joint. A lip of the lateral calcaneal process was removed with osteotome to enable the talonavicular joint to be seen. A Crego retractor was then placed over the neck of the talus, and articular cartilage of the three joints to be fused was excised. Wedge osteotomies of the bones were performed to correct the remainder of the deformity. Two or three staples were placed to secure the fusion in position.

Postoperative management was no weight-bearing in a short leg-cast for six weeks, then weight-bearing to tolerance for another two to six weeks, so total immobilization in the cast was from eight to 12 weeks. A polypropylene ankle-foot orthosis was measured during the first change of cast. After discontinuing the cast the orthosis was used for four to six months. Hindfoot stabilization is superior with the polypropylene orthosis compared to the metal upright orthosis.

Results

There were no immediate postoperative complications. Clinically, 23 fusions were

TABLE III
Ambulatory status before and after triple arthrodesis

	Indication for surgery				Total	
	Pain		Deformity		Preop.	Postop.
	Preop.	Postop.	Preop.	Postop.	Preop.	Postop.
Ambulators	5	4	13	11	18	15
Non-ambulators	—	1	2	4	2	5

in good position (neutral or slight valgus hindfoot, with no residual forefoot deformity). The other two triple arthrodeses were found to be in less than the optimal position. One patient who had had earlier calcaneal osteotomy still had significant calcaneal valgus, although this was improved after the triple arthrodeses. The second patient had residual 20° equinus from an equinovalgus position preoperatively, and there was no recurrence of deformity. No patients required refusion, but several had the staples removed because of pain. There were no major postoperative deformities necessitating surgery, and none of the 25 triple arthrodeses required further soft-tissue or bony surgery. Three patients became independent of braces after the fusion, and none became dependent on braces.

Ambulation

Ambulatory status before and after triple arthrodesis and its relationship to indications for surgery were carefully examined (Table III). 15 patients (18 feet) were functional ambulators postoperatively, but there was no significant difference in the type of ambulation, *i.e.* community versus household. The two patients (three feet) who were functional non-ambulators preoperatively remained so. Three patients (four feet) stopped ambulating postoperatively. The indications for fusion for these three were pain in one case (one foot) and deformity in the other two (three feet). The patient with the painful foot had spastic cerebral palsy, with total body involvement, and was ambulatory in short leg-braces preoperatively. He never walked after the arthrodesis, which was done at age 14½. The second patient who did not continue ambulation underwent bilateral triple arthrodeses. Preoperatively he had

been a community ambulator, using canes but no braces. In addition to planovalgus feet, he had a crouch gait with hamstring spasticity. The fusions were combined with bilateral hamstring lengthenings at age 15. He never walked after these procedures. The third patient had a right hemiplegia secondary to head trauma. He was ambulatory with a right ankle-foot orthosis when he underwent the triple arthrodesis at age 13. He stopped ambulating three years postoperatively, with a 20° residual equinus deformity.

Radiographic results

X-rays of the feet in plaster were not helpful because the technique missed the tarsal bones of interest and the cast material obscured the hindfoot. 15 patients with 18 triple arthrodeses were assessed. All calcaneocuboid and talocalcaneal joints fused, as in the good result shown in Figure 1. There were four painless talonavicular non-unions, two in patients who became non-ambulatory and two in ambulators (Fig. 2). Two patients also had medial subluxation of the navicular on the talus, but these joints fused. Resorption of the neck of the talus was also observed in two patients. There was no degenerative joint disease involving the other bones of the foot, but longer follow-up is required to assess this correctly.

Discussion

Triple arthrodeses were successful in correcting deformity in 18 of 20 feet, in completely relieving pain in four out of five feet. Two patients were non-ambulatory prior to the surgery, which was successful in correcting the deformity but they did not walk. Three other functionally ambulatory patients had successful correction of deformity or of pain, but stopped walking. The timing of surgery therefore is crucial,



Fig. 1. Radiograph of triple arthrodesis with solid fusion and good result.



Fig. 2. Lateral radiograph of talonavicular non-union in a non-ambulatory patient.

especially if the patient's walking is declining. Adolescent patients may decrease their walking for several reasons, but motivation, balance, obesity and hip and knee deformities probably are more important factors than foot posture. The 15 other patients' ambulatory status did not change, but there was no improvement in the type of ambulation.

There were no painful non-unions, although talonavicular non-unions occurred in four of the 18 triple arthrodeses reviewed radiographically. No patient with preoperative deformity developed pain postoperatively, nor was there any need for bony or soft-tissue procedures directly related to the triple arthrodesis.

Triple arthrodesis is an excellent and reliable operation for patients with spastic cerebral palsy, for permanent correction of deformity and relief of pain. However, it does not increase the duration or alter the type of ambulation.

Authors' Appointments

*M. Lloyd Ireland, M.D.;

Mark Hoffer, M.D.;

Division of Orthopaedic Surgery, University of California Irvine Medical Center, Orange, CA 92668.

*Correspondence to first author at Department of Orthopaedic Surgery, UCI Medical Center, 101 City Drive South, Orange, CA 92668.

SUMMARY

A retrospective review was done of 20 children with spastic cerebral palsy who had had a total of 25 triple arthrodeses at Rancho Los Amigos Hospital. The average age at the time of surgery was 15.5 years and average follow-up was 4.5 years. Indications for surgery were progressive deformity (15) and relief of pain (five). The deformities was planovalgus (12), equinovalgus (six), equinovarus (six) and calcaneovalgus (one). All 13 patients with braces had problems in wearing them. Two patients were non-ambulatory preoperatively and remained so after fusion. Of the 18 who were ambulatory preoperatively, 15 remained so and there was no change in the type of ambulation: the other three stopped ambulating. Three children were made independent of braces. It is concluded that triple arthrodesis is an excellent procedure for children with spastic cerebral palsy, to correct deformity and relieve pain, but it should be done while the children are still walking for the best chances of continued ambulation.

RÉSUMÉ

Triple arthrodèse chez les enfants IMC spastiques

Une étude rétrospective a été faite chez 20 jeunes IMC à forme spastique ayant eu un total de 25 triple arthrodèse au Rancho Los Amigos Hospital. La moyenne d'âge au moment des interventions était de 15,5 ans et la moyenne d'observations post-opératoires était de 4,5 années. L'indication de la chirurgie a été la déformation évolutive (15 cas), le soulagement des douleurs (5 cas). Les déformations étaient le pied plat valgus (12 cas), le valgus équin (six cas), le varus équin (six cas) et le valgus calcanéen (un cas). Les 13 sujets équipés de prothèse avaient du mal à les supporter. Deux sujets, ne marchant pas avant l'intervention, sont restés tels après l'arthrodèse. Parmi les 18 qui marchaient avant l'intervention, 15 conservèrent la marche, sans modification du type de déambulation; les trois autres perdirent la marche. Trois sujets furent rendus indépendants de prothèse. Les auteurs concluent que la triple arthrodèse est une excellente intervention chez les jeunes IMC spastiques pour corriger les déformations et soulager les douleurs, mais qu'elles ne devraient être faites que chez des enfants ayant encore la marche pour avoir les meilleures chances de la conserver.

ZUSAMMENFASSUNG

Tripelarthrodese bei Kindern mit spastischer Cerebralparese

Dies ist ein retrospektiver Überblick über 20 Kinder mit spastischer Cerebralparese, bei denen insgesamt 25

Tripelarthrodesen im Rancho Los Amigos Hospital durchgeführt worden waren. Das Durchschnittsalter bei der Operation war 15.5 Jahre und die durchschnittliche Kontrolldauer betrug 4.5 Jahre. Die Indikationen für die Operation waren: progressive Deformierung (15) und Schmerzlinderung (fünf). Die Deformierungen bestanden in planovalgus (12), equinovalgus (sechs), equinovarus (sechs) und calcaneovalgus (eine). Alle 13 Patienten mit Bandagen hatten Schwierigkeiten damit. Zwei Patienten konnten präoperativ nicht laufen und das änderte sich auch nicht durch die Operation. Von den 18 Patienten, die präoperativ laufen konnten, liefen 15 genauso wie vorher, die restlichen drei konnten nicht mehr laufen. Drei Kinder brauchten keine Bandagen mehr. Die Autoren sind der Meinung, daß die Tripelarthrodesese eine ausgezeichnete Methode ist, bei Kindern mit spastischer Cerebralparese Deformierungen zu korrigieren und Schmerzen zu lindern. Sie sollte aber zu einem Zeitpunkt durchgeführt werden, wenn die Kinder noch laufen können, weil dann die größte Chance besteht, daß die Kinder gehfähig bleiben.

RESUMEN

Triple arthrodesis para niños con parálisis cerebral espástica

Se hizo una revisión retrospectiva de 20 niños con parálisis cerebral espástica a quienes se les había practicado un total de 25 arthrodesis triple en el Hospital Rancho los Amigos. La edad media en el momento de la operación era de 15'5 años y el seguimiento se hizo durante un promedio de 4'5 años. Las indicaciones de la intervención fueron deformidad progresiva (15) y alivio del dolor (cinco). Las deformidades eran planovalgus (12), equinovalgus (seis) y calcánevus (uno). Todos los 13 pacientes con férulas tenían problemas para llevarlas. Dos pacientes no andaban antes de la operación y siguieron así después de ella. De los 18 que andaban antes de la intervención, 15 siguieron así y no se operó ningún cambio en el tipo de marcha; los otros tres dejaron de andar. Tres niños se independizaron de las férulas. Se concluye que la arthrodesis triple es un procedimiento excelente para niños con parálisis cerebral espástica, para corregir deformidades y aliviar el dolor, pero debe ser practicada cuando el niño todavía anda para mantener el máximo de posibilidades de que pueda continua andando.

References

Horstmann, H. (1977) 'Triple arthrodesis in cerebral palsy.' *Orthopaedic Transactions*, 1 (1), 109. (Abstract.)

Malekafzali, S., Rosenthal, R. K. (1981) 'Triple arthrodesis in cerebral palsy.' *Orthopaedic Transactions*, 5 (2), 192. (Abstract.)