



Complications following correction of the planovalgus foot in cerebral palsy by arthroereisis

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Pes valgus is a pathological condition which occurs in up to 25% of patients with cerebral palsy. Its correction in early age is essential to prevent progression of the deformity and to optimize the patient's function. In younger patients arthroereisis can be considered as a treatment that fills the void between orthotics and arthrodesis. We treated 15 patients (27 feet) with intra-or extra-sinus tarsi arthroereisis. Concomitant Achilles tendon lengthening was performed in 12 feet. Results were good in 19 feet and poor in 8. Even though arthroereisis presents some complications, it can be considered a useful treatment to delay or avoid a Grice subtalar arthrodesis in flexible pes valgus due to cerebral palsy.

Keyword : cerebral palsy ; pes valgus ; flat foot ; arthroereisis ; complication.

INTRODUCTION

Pes valgus is a pathological condition which occurs in up to 25% of patients with cerebral palsy. Up to 64% of the diplegic and tetraplegic patients present with this deformity (1).

Its appropriate treatment in cerebral palsy is a complicated matter. The pes valgus remains flexible until adolescence (8), so deformity correction in early age is essential to prevent its progression and to optimize the patient's function (13). In younger patients arthroereisis can be considered a way of treatment that fills the void between orthotics and arthrodesis (3).

The aim of our study is to evaluate the possibility, in patients with flexible pes valgus deformity not responsive to orthotic treatment, to delay or avoid the Grice subtalar arthrodesis.

MATERIALS AND METHODS

Forty nine ambulating cerebral palsy patients with pes valgus (67 feet) were treated in the Dipartimento di Scienze dell'Apparato Locomotore della "Sapienza" Università di Roma between 1997 and 2005.

An inclusion criterion for our retrospective study was a minimum of 2 years follow-up.

Fifteen patients (27 feet) treated with an intra-sinus tarsi Giannini screw (GS – expanding teflon cylinder with an internal stainless steel screw, Stryker Italia, Formello, RM, Italy) or an extra-sinus tarsi calcaneo stop

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(CS – stainless steel screw ; Mikai, Genoa, GE, Italy) met our inclusion criteria : seven were tetraplegic, five paraplegic and three diplegic. Concomitant Achilles tendon lengthening was performed in twelve feet with a fixed Achilles tendon contracture. In case of concomitant Achilles tendon lengthening a cast was applied for 3-4 weeks.

The GS group included eight patients (14 feet) : four tetraplegic, two paraplegic and two diplegic. Three patients were male and five were female.

The CS group included seven patients (13 feet) : three tetraplegic, three paraplegic and one diplegic. Four patients were male and three were female.

In all patients a clinical and radiographic evaluation was performed preoperatively, postoperatively and at last follow-up. Clinical evaluation was based on the presence of pain and loss of function ; standing radiographs were made to measure the lateral talocalcaneal angle (TCA - normal value 30-40°) and Kite's angle (KA - normal value 20-50°).

Indications for surgery were a flexible deformity, lack of response to orthotic treatment and presence of pain or loss of function.

The outcome was considered good if, at the last follow-up, the patient reported no pain and showed functional improvement, radiographic angles were normal or improved over the preoperative values and if no device-related complications were seen.

Revision surgery, when performed, consisted of Grice subtalar arthrodesis following device removal.

RESULTS (table I)

In the GS group (8 patients, 14 feet), six patients presented preoperatively with a loss of function (75%) and five feet were painful (35.7%). Concomitant Achilles tendon lengthening was performed in eight feet (57.1%) in the GS group. The mean age at surgery was 11.7 years (range 9.9 to 13.6 years) and the mean follow-up was 6 years (range 2.8 to 9.3 years).

Results were good in eleven feet (78.5%) and poor in three (implant dislocation, fig 1). The average time between primary and revision surgery was 1.3 year (range 0.9 to 1.6 year).

In the CS group (7 patients, 13 feet), six patients presented preoperatively with a loss of function (85.7%) and four feet were painful (30.7%). Concomitant Achilles tendon lengthening was per-

formed in four feet in the CS group (30.7%). The mean age at surgery was 12.5 years (range 9.3 to 14.5 years) and the mean follow-up was 4.2 years (range 2.2 to 6.3 years).

Results were good in eight feet (61.5%) and poor in five (2 implant fractures (fig 2) and 3 implant dislocations (fig 3)). The average time between primary and revision surgery was 1.9 year (range 1 to 2.7 years).

DISCUSSION

Pes valgus can occur in association with a variety of paralytic disorders ; in patients who have cerebral palsy, it is the result of muscle spasticity, muscle weakness and altered biomechanics during walking (3).

In the spastic pes valgus there is an eversion and equinus inclination of the calcaneus and midfoot abduction which results in prominence of the talus head medially. The deformity remains flexible until adolescence ; until that age, the foot can be passively manipulated into the corrected position by planar flexion of the ankle and inversion of the foot (8).

Complications are abnormal shoe wear and pain from calluses and sores in the area of the talar head ; over time, hallux valgus develops in response to the everted foot position, and may also be painful (7).

Different authors have recognized the spastic peroneal muscles as the major deforming force. Skinner and Lester (12) analyzed a dynamic EMG in 13 children with spastic diplegia to observe their hindfoot valgus deformities. They described three different patterns of muscle activity : 1. hyperactive peroneal muscles with a strong posterior tibial muscle ; 2. hyperactive peroneals with a weak posterior tibial muscle ; and 3. hyperactive extensor digitorum longus muscles.

Other factors that may be involved in pes valgus pathogenesis are : 1. calcaneal plantar flexion due to gastrocnemius-soleus contracture ; 2. variations in ligamentous laxity (15) ; and 3. persistent foetal medial deviation of the talar neck (2).

The appropriate treatment of pes valgus in cerebral palsy is a complicated matter ; early control of the deformity is essential to prevent progression to a more severe foot condition and in turn to

Table I. — Results

Patient	Sex	Diagnosis	Pain	Loss of function	Age at surgery (yy,mm)	Duration of follow-up (yy,mm)	Surgery (side)	Achilles tendon lengthening	Result	Complications	Time to revision (yy,mm)
1	M	P	Y	Y	10.5	9.3	GS (Bil)	Y (Bil)	Good	N	-
2	F	D	N	N	11.1	4.6	GS (R)	Y (R)	Good	N	-
3	F	T	Y	Y	13.6	6.9	GS (Bil)	N	Poor	dislocation (Bil)	0.9
4	F	T	Y	Y	11.8	3.1	GS (Bil)	Y (Bil)	Poor	dislocation (R)	1.6
5	M	T	N	N	9.9	8	GS (Bil)	N	Good	N	-
6	M	D	Y	Y	12.2	7.3	GS (R)	N	Good	N	-
7	F	T	N	Y	13.1	2.8	GS (Bil)	Y (Bil)	Good	N	-
8	F	P	Y	Y	11.11	6.1	GS (Bil)	Y (L)	Good	N	-
9	M	D	N	Y	14.2	6.3	CS (L)	N	Poor	fracture	2.7
10	M	P	Y	Y	10.3	3.8	CS (Bil)	N	Poor	dislocation (L)	2.1
11	F	T	N	N	9.3	2.2	CS (Bil)	N	Good	N	-
12	M	T	Y	Y	13.11	5.6	CS (Bil)	Y (Bil)	Poor	fracture (L) + dislocation (R)	1 + 1.8
13	F	P	Y	Y	14.5	4.5	CS (Bil)	N	Poor	dislocation (L)	1.3
14	F	T	N	Y	12.1	3.2	CS (Bil)	Y (Bil)	Good	N	-
15	M	P	Y	Y	14.3	4.11	CS (Bil)	N	Poor	dislocation	2.4

M = male ; F = female ; T = tetraplegia ; P = paraplegia ; D = diplegia.

Y = yes ; N = no ; GS = Giannini screw ; CS = calcaneo stop ; Bil = bilateral ; R = right ; L = left.



Fig. 1. — Giannini screw dislocation



Fig. 3. — Calcaneo stop dislocation



Fig. 2. — Calcaneo stop fracture

optimize gait training (3,6,14). On the other hand, early surgery seems to carry a risk of late pes varus. Pes valgus thought to be severe in children under the age of 4 may no longer appear so severe at 6-7 years of age ; this decrease in severity seems to occur as the foot equilibrium reactions reverse from the primitive infantile eversion reaction to the more mature inversion foot reaction (5). Another natural phenomenon which accounts for a decrease in pes valgus may be decreasing ligamentous laxity with age, presumably due to more crosslinking of the collagen (8).

Orthotics may be adequate to relieve pain in some patients but, after conservative measures have been exhausted, surgical treatment may have to be considered (6).

Surgical options described are : 1. peroneal tendon transfer ; 2. peroneus brevis intramuscular tenotomy ; 3. extra-articular subtalar arthrodesis (Grice technique and its modifications) ; 4. arthroereisis ; 5. open wedge calcaneal osteotomy ; 6. medial displacement osteotomy of the calcaneus ; 7. calcaneal lengthening ; 8. calcaneal-cuboid-cuneiform osteotomy ; and 9. triple arthrodesis (8).

Extra-articular subtalar arthrodesis has been the standard operation to correct spastic pes valgus in children since Grice described this operation for valgus foot deformities secondary to poliomyelitis (4).

Arthroereisis is the operative limitation of joint motion, unlike an arthrodesis that eliminates the joint motion ; this technique appears to be useful, because it does not involve the extensive surgical trauma associated with arthrodesis.

Arthroereisis complications can be divided into general and implant specific. General complications include malposition, overcorrection, undercorrection, wrong implant size, loss of position and persistent sinus tarsi pain and tenderness. Implant specific complications are related to the specific features of the device (material, geometry, and fixation) and how it is designed to function (self-locking wedge, axis-altering device, and impact-locking device) : as there are wear debris, foreign body reaction, implant degradation, and implant fracture (10).

Crawford *et al* (3) corrected the position of the spastic pes valgus by a laterally placed staple across the subtalar joint in the body of the talus and the calcaneus. Of the 20 patients (31 feet) in their study, 18 had cerebral palsy ; concomitant soft tissue surgery was performed in 17 patients. An above-knee cast was applied and worn for 6 weeks, following which an ankle foot orthosis was used for 6 months. Age at surgery ranged from 2 years to 10 years 10 months ; results were satisfactory in 84% and unsatisfactory in 16%. Complications were minor and only one staple extruded.

Crawford's original intention was to use the staple as a temporary correction until the child was old enough to have an extra-articular subtalar arthrodesis ; however, as the follow-up showed maintenance of the correction with the staple, removal of the staple and Grice arthrodesis was not considered necessary.

Sanchez *et al* (11) performed subtalar joint stapling in flexible, severe pes valgus due to a neuromuscular condition. Of the 22 patients (34 feet) 16 had cerebral palsy ; concomitant soft tissue surgery was performed in 29 feet. An above-knee cast was worn for 6-8 weeks, following which an ankle foot orthosis was used for a prolonged period of time. Mean age at surgery was 7.5 years ; results were satisfactory in 53% and unsatisfactory in 47%. Of the 34 feet, 16 required revision at an average of 39 months after surgery. Sanchez *et al* concluded that the long-term results of staple arthroereisis were unpredictable and no longer recommended it for the correction of pes valgus due to neuromuscular conditions.

Vedantam *et al* (14) corrected the position of the neurological pes valgus by a STA-Peg implant (Dow Corning Wright Corporation, Arlington, TN, U.S.A.) inserted laterally into the subtalar joint. Of the 78 patients (140 feet), 72 had cerebral palsy ; concomitant soft tissue surgery was performed in 73 patients. A short leg cast was applied and worn for 4 weeks after which an ankle foot orthosis was used for 6 months. Mean age at surgery was 7 years 9 months ; results were satisfactory in 96.4% and unsatisfactory in 3.6%. Of the 140 feet, 5 required revision at an average of 30 months after surgery.

The aim of our study was to evaluate the possibility of delaying or avoiding the Grice subtalar arthrodesis in patients with flexible pes valgus deformity not responsive to orthotic treatment.

Of the 27 feet treated in our study, 8 feet presented complications : 6 implant dislocations (3 GS and 3 CS) and 2 implant fractures (CS), that required a revision to remove the device and to perform a Grice subtalar arthrodesis.

Analyzing our complications, we noted that in five of six cases with implant dislocations (2 of 3 GS and 3 of 3 CS) and in one of two cases with implant fractures, we had not performed soft tissue surgery (Achilles tendon lengthening). It would thus appear that adequate soft tissue surgery is often needed to balance muscle forces around the joint (9), thus reducing the risk of arthroereisis failure.

CONCLUSIONS

1. Soft tissue surgery is often necessary to balance the muscle forces around the subtalar joint and also to ease the positioning of the arthroereisis device ;

2. As we can only intervene on the secondary manifestations of cerebral palsy, but cannot modify the neurological defect, there is a risk of progressive worsening even in cases that are initially satisfactory.

Even though arthroereisis presents some complications, it can be considered a useful treatment to delay or avoid a Grice subtalar arthrodesis in flexible pes valgus due to cerebral palsy.

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