Acta Orthop. Belg., 2011, **77**, 652-658

ORIGINAL STUDY

Subjective outcome of reconstruction of the adult acquired neurological equinovarus foot

Rui LEMOS, Alexandre PEREIRA

From the Centro Hospitalar do Porto – Hospital de Santo António, Porto, Portugal

A retrospective study was done of the subjective outcome of surgical correction of a spastic equinovarus foot deformity in 27 adult patients with acquired spastic hemiplegia. The mean age of the patients was 49 years and the mean follow-up period was 29 months. The patients were submitted to individualized soft-tissue surgery intended to correct their deformities and rebalance the affected joints, and subsequently subjected to a standard rehabilitation protocol. The assessment was based on the clinical records and on a questionnaire sent to the patients about relevant aspects of their gait, lifestyle and untoward effects and complications. The results have shown that patients experience frank improvement in terms of gait, orthostatic posture, self-esteem and quality of life. Transient or permanent adverse effects occurred in 11 of the 27 patients. The changes induced by surgery to reduce the imbalance and deformity of the foot have a considerable impact on independence and quality of life of these patients despite the high rate of complications.

Keywords : equinovarus ; spastic hemiplegia ; soft tissue reconstruction ; tendon transfer ; qualitative evaluation.

INTRODUCTION

The aim of this study was to evaluate patient satisfaction and subjective outcome after surgical correction of acquired spastic equinovarus foot deformity. Patients with spastic hemiplegia acquired in adulthood and caused by either stroke or head injury, have a characteristic and almost uniform deformity of the foot and ankle. This deformity is the result of static and dynamic imbalance of agonist and antagonist muscles that control the joints of the foot and ankle and are generally composed of a combination of equinus, inversion of the foot and claw toes (*2,11,12,16*). The foot deformity is the most problematic deformity of the lower limb in patients with acquired hemiplegia, but knee and hip in most of these patients are involved also (*13*). Many patients who survive brain damage will continue walking with limitations, aided by external and human support and often dependent on caregivers (*15*).

Perry and Garrett originated the surgical procedure of split anterior tibialis tendon transfer (SPLATT) for spastic varus hindfoot and initially reported its use in children with cerebral palsy (*5*). Success of surgical correction for spastic equinovarus in hemiplegic stroke (*1,10*) and after traumatic brain injury (*7,8*) in adult patients is well known. However, these studies emphasize objective aspects

■ Rui Lemos, MD, Orthopaedic surgeon.
■ Alexandre Pereira, MD, Orthopaedic resident.
Centro Hospitalar do Porto – Hospital de Santo António, Porto, Portugal.
Correspondence : Alexandre Pereira, Orthopaedic Department, Centro Hospitalar do Porto – Hospital de Santo António, 4099-001 Porto, Portugal.
E-mail : manelalex@hotmail.com

No benefits or funds were received in support of this study

of treatment outcome such as the abandonment of ankle foot orthosis and gait variables, with no attempt to explore patient opinion and subjective experience.

This study is focused on the observation of the effect of surgery on gait and standing position and on various aspects of comfort and everyday activities by the patient and their caregivers. The parameters selected for examination were known to be influenced by surgery, related to autonomy, well-being and motor performance, and have only rarely been the subject of publications.

PATIENTS AND METHODS

The study group consists of 27 patients, drawn from a cohort of 40 patients who had undergone foot surgery for spastic deformity. Thirteen patients were excluded from the study : 6 patients had cerebral palsy, and incurred neurological damage in the perinatal period ; 4 patients were excluded for diplegia or inability to walk ; in one the follow-up time was less than 1 year and two were lost for follow-up.

Surgery by one senior surgeon (RL) was performed between January 2003 and January 2010. The surgery consisted of lengthening the contracted tendons and/or hyperactive myotendinous units, according to the findings on clinical examination (gait analysis and electromyography). The Achilles tendon and the long flexors of the toes and hallux were usually involved. The posterior tibial tendon, though less responsible for the deformity in cases of acquired spasticity (*9*) was almost always lengthened, except in cases where clinical examination ruled out completely its dynamic and static hyperactivity. The anterior tibial tendon, usually hyperactive, was largely responsible for the varus deformity of the foot along with the paralysis of the peroneal muscles (*4-6*). A split transfer was done to the cuboid bone, where it was fixed by two bone anchors. After intervention, the limb was immobilized in a non-weight bearing below-knee cast with the ankle at 90° and the toes extended for six weeks, followed by a removable AFO splint (Ankle Foot Orthosis) and gradual weight-bearing and controlled mobilization without splint. At 10 weeks the splint was completely discontinued and the load on the operated limb was allowed without restrictions. Physical therapy was generally discontinued at 3-6 months postoperatively. Patients were then encouraged to exploit their new capabilities.

Patient's data were analyzed reviewing the clinical records and an anonymous questionnaire (see Appendix) was sent to the patient about relevant aspects related with the deformity. With the exception of one case, the answers were given at home by the patient and his caretakers uninvolved in the therapeutic process. Immediate and long-term surgical complications were recorded.

RESULTS

The mean age at the time of surgery of the 27 patients (10 women and 17 men) was 49 years (range : 18 to 72 years). The mean follow-up period was 29 months (range : 12 to 84 months) and at least 2 years in 11 patients. Hemiplegia of the non-dominant side was present in 16 cases and hemiplegia of the dominant side in 10 cases. In one patient, it was not possible to determine the dominant side. The cause was traumatic brain injury (TBI) in 6/27 patients and cerebrovascular accident (CVA) in 21/27. Deformities were not significantly different between the two aetiological groups and all included in the same study group, as in the study by Pinzur *et al* (*13*). The paralysis dated from 7.1 years on average (range : 2 to 22 years).

All the patients had been previously treated with physical therapy, supplemented with injections of botulinum toxin in 14 patients and oral medication for spasticity in 13 patients. The three modalities of conservative treatment combined were applied in 9 patients.

Twenty-six patients had a triple deformity, combining equinus, varus of the foot, and claw toes, and all deformities were corrected in the same surgical procedure. In one patient the equinus was the only significant deformity. In some patients the typical claw toes spared the hallux, so not all were subject to correction.

Survey results are summarized in tables I, II and III. Table I shows that all patients became independent of the AFO splint and most of them even

Table I. — Dependency on walking assistance before and after surgery

		Before surgery	After surgery
Use of Ankle Foot Orthosis	At home	16/27 (59%)	0/27 (0%)
	Outside home	18/26 (69%)	0/27 (0%)
External support (cane/tripod)	At home	15/27 (56%)	6/27 (22%)
	Outside home	14/26 (54%)	10/26 (38%)
Support staff	At home	10/27 (37%)	3/27 (11%)
	Outside home	12/26 (46%)	7/26 (27%)
Total autonomy	At home	4/27 (15%)	20/27 (74%)
	Outside home	4/26 (15%)	11/26 (42%)

Table II. — Perception of improvement in gait and posture variables

	Worse	Equal	Better
Speed of gait	1 (3.7%)	8 (29.6%)	18 (66.7%)
Gait Distance	0 (0%)	7 (25.9%)	20 (74.1%)
Irregular floor	0 (0%)	5 (18.5%)	22 (81.5%)
Voluntary control of foot	0 (0%)	4 (14.8%)	23 (85.2%)
Performance	0 (0%)	2 (7.4%)	25 (92.6%)
Balance	1 (3.7%)	1 (3.7%)	25 (92.6%)
Falls	1 (3.7%)	11 (40.7%)	15 (55.6%)

Table III. — Perception of improvement in lifestyle and comfort variables

	Worst	Equal	Better
Sensorial changes	0 (0%)	4 (14.8%)	23 (85.2%)
Comfort	1 (3.7%)	7 (25.9%)	19 (70.4%)
Calluses and ingrown toenails	0 (0%)	15 (55.6%)	12 (44.4%)
Use of footwear	0 (0%)	2 (7.4%)	25 (92.6%)
General hygiene	0 (0%)	10 (37%)	17 (63%)
Personal image	0 (0%)	2 (7.4%)	25 (92.6%)
Quality of life	0 (0%)	2 (7.4%)	25 (92.6%)

became independent from other technical aids or human support particularly inside their homes. All patients noticed improvement in at least three variables of gait and posture, except one patient who noticed worsening in speed of gait, balance and falls (Table II). Almost all the patients (25) reported improvement in terms of sensitivity of the foot, use of footwear, personal image and quality of life (Table III).

Tables IV and V summarize the complications collected from the clinical records and from the patient's survey. They are referred to as adverse effects and are divided into transient (Table IV) and permanent (Table V). All the 5 patients that have experienced a transient adverse effect are included in the 11 patients that have permanent sequellae.

DISCUSSION

Gait and posture

The autonomy in mobility was assessed by studying the way patients became independent from technical and human aids to walk after surgery. This is a constant in all studies on this topic (*3,5,14,15*) and is generally regarded as an objective indicator of

Table IV. — Temporary adverse effects of the corrective surgery

Thrombophlebitis	3
Superficial infections with suture dehiscence	2

Table V. — Permanent adverse effects of the corrective surgery

Residual pain	3
Residual oedema	2
Diminished propulsive force	6

improvement. We independently evaluated two different levels of gait difficulty : the interior of patient's homes generally adapted to their problems (27 patients), and the outside (26 patients) with a complex set of barriers that hinder walking (One patient did not agree to leave home and was excluded for this part of the evaluation). As walking aids we considered the use of an AFO splint that controls equinus and inversion of the foot and facilitates gait, the need for a tripod or a cane as an external support and the need for human support of the staff, both mainly used by several for safety sake because of a poor balance and possible convulsions.

Speed is generally accepted as being the most important parameter of improvement (*3*). Several authors demonstrated that walking speed evolved positively after surgical reduction of the deformity (*3,14,16*). We investigated subjective perception by the patient and caregivers of gait speed before and after surgery, and willingness to walk in everyday life. A great percentage of the patients noted improvement in speed and time spent walking.

In general, hemiplegic patients have great difficulty in overcoming obstacles and gaps on the walking surface : in these conditions they must rely on the fully loaded and disabled foot to overcome the obstacle and make the necessary changes in body position. Balance during standing and walking is very unsecure in the hemiplegic patient. This difficulty has many negative implications in both the personal image and in tasks like dressing or personal hygiene. Once the problems of the foot deformity are solved, the hip and knee functions tend to improve, though not completely (*12*).

Lifestyle and comfort

Hemiplegic patients often complain of discomfort in the foot, which is expressed by dysaesthesia and cold sensations. We believe that this condition is related to a combination of central and peripheral neurological factors, the latter caused by abnormal foot posture with compression of peripheral nerves. We learned from our patients that these changes could improve with the correction of deformity, so we included this modification in the final evaluation, although we did not find any information in the literature on this subject. Contributors to the observed sensorial improvement might be the widening of the contact area of the foot with the ground and suppression of the splint. Also on many occasions uncomfortable special footwear needed to relieve digital problems or to fit the splint, was discarded.

We believe that several elements add to a better generalized personal image and impression of quality of life in these patients : the independence from a splint, improvement in posture and gait, and overall reduction in muscular hyperactivity in the entire hemisphere, coupled with a reduced effort to move. We observed in fact a substantial improvement of curving around the body on the paretic side in the operated patients.

Adverse effects

We found that 16 of the 27 patients did not experience any negative aspects with the surgical treatment. Despite the low rate of complications reported in the literature and despite appropriate antibiotic and antithrombotic prophylaxis, we found, however, a higher incidence of infection, trombophlebitis and residual oedema maybe related to co-morbid conditions (diabetes, venous insufficiency). Some patients report pain and a sensation of diminishing force.

Limitations of this study are the small sample of patients with mixed pathology (head trauma and vascular disorders). Although the neurological and deformity status is similar with both groups of pathology, victims of head trauma tend to be younger and have a greater potential for recovery.

Furthermore the analysis being based on subjective evaluation, is very dependent on the unstable mood of these neurological patients.

CONCLUSIONS

This study corroborates all that has been published on the positive results of surgical treatment of equinovarus foot in the adult. Our assessment is largely based on the patient's opinion and expectations. This study added features that are modified with the surgery and are object of scarce research.

The benefit of the surgery is most obvious on gait and posture. In our study patients reported having increased their independence, both in- and outside their homes, and were able to walk longer, better and faster than before surgery. Difficulties in locomotion caused by floor irregularities and steps clearly decreased after surgery. The posture in standing position, also appeared much improved with a plantigrade and rebalanced foot. Moreover, there was a clear improvement in quality of life and self-esteem. Despite all these benefits, reconstructive surgery carries a significant rate of adverse effects, often difficult to objectify, which may jeopardize its success.

REFERENCES

1. **Banks HH.** The management of spastic deformities of the foot and ankle. *Clin Orthop Relat Res* 1977 ; 122 : 70-76.
2. **Bobath B.** *Adult Hemiplegia : Evaluation and Treatment*. William Heinemann Medical Books, London, Ed. 2, 1978.
3. **Carda S, Bertoni M, Zerbinati P *et al.*** Gait changes after tendon functional surgery for equinovarus foot in patients with stroke : Assessement of temporo-spatial, kinetic and kinematic parameters in 177 patients. *Am J Phys Med Rehabil* 2009 ; 88 : 292-301.
4. **Fuller DA, Mccarthy JJ, Keenan MA.** The use of the absorbable interference screw for a split anterior tibial tendon (SPLATT) transfer procedure. *Orthopedics* 2004 ; 27 : 372-374.
5. **Hoffer MM, Reiswig JA, Garrett AM, Perry J.** The split anterior tibial tendon transfer in the treatment of spastic varus hindfoot in childhood. *Orthop Clin North Am* 1974 ; 5 : 31-38.
6. **Hosalkar H, Goebel J, Reddy S, Pandya NK, Keenan MA.** Fixation techniques for split anterior tibialis transfer in spastic equinovarus feet. *Clin Orthop Relat Res* 2008 ; 466 : 2500-2506.
7. **Keenan MA, Creighton J, Garland DE, Moore T.** Surgical correction of spastic equinovarus deformity in the adult head trauma patient. *Foot Ankle* 1984 ; 5 : 35-41.
8. **Lawrence SJ, Botte MJ.** Management of the adult, spastic, equinovarus foot deformity. *Foot Ankle Int* 1994 ; 15 : 340-346.
9. **Mooney V, Goodman F.** Surgical approaches to lower extremity disability secondary to strokes. *Clin Orthop Relat Res* 1969 ; 63 : 142-152.
10. **Ono K, Hiroshima K, Tada K, Inoue A.** Anterior transfer of the toe flexors for equinovarus deformity of the foot. *Int Orthop* 1980 ; 4 : 225-229.
11. **Perry J.** The mechanics of walking in hemiplegia. *Clin Orthop Relat Res* 1969 ; 63 : 23-31.
12. **Pinzur MS, Levine DP, Trimble J, Haag K, Sherman R.** Qualitative and quantitative gait phase analysis by continuous monitoring of inter-ankle distance. *J Rehab Res Devel* 1984 ; 21 : 50-53.y 1.
13. **Pinzur MS, Sherman R, DiMonte-Levine P, Kett N, Trimble J.** Adult-onset hemiplegia : changes in gait after muscle-balancing procedures to correct the equinus deformity. *J Bone Joint Surg* 1986 ; 68-A : 1249-1257.
14. **Reddy S, Kususma S, Hosalkar H, Keenan MA.** Surgery can reduce the non- operative care associated with an equinovarus foot deformity. *Clin Orthop Relat Res* 2008 ; 466 : 1683-1687.
15. **Roper BA, Williams A, King JB.** The surgical treatment of equinovarus deformity in adults with spasticity. *J Bone Joint Surg* 1978 ; 60-A : 533-535.
16. **Schroeder H, Coutts R, Lyden P, Billings E Jr, Nickel VL.** Gait parameters following stroke : A practical assessment. *J Rehab Res Devel* 1995 ; 32 : 25-31.

Appendix. — Questionnaire to be filled out by the patients and their caretakers

1. Birthday _____
2. Date of the cerebral injury _____
3. Date of the foot surgery _____
4. Hand dominance _____
5. Which **side** was paralyzed :
   a. Right ☐
   b. Left ☐
6. The **cause** of your foot problem was :
   a. Stroke (thrombosis / embolism / bleeding) ☐
   b. A head injury ☐
   c. Birth paralysis ☐
   d. Another _____
7. Were there other problems in the affected limb ?
8. Were there other problems in the other limbs ?
9. **Form of treatment** before surgery ?
   a. Oral medication for spasticity ☐
   b. Physiotherapy ☐
   c. Infiltration with botulinum toxin ☐
10. I**mmediate complications** after the surgery of the foot ?
    a. Infection ☐
    b. Problems with wound healing ☐
    c. Skin pressure ulcers ☐
    d. Phlebitis or thrombosis in the leg ☐
    e. Another _____
11. One year after surgery, did you or do you **feel any of these symptoms ?**
    a. Swelling ☐
    b. Pain ☐
    c. Decreased mobility of the foot ☐
    d. Changes in sensitivity ☐
    e. Decreased strength ☐
    f. Another _____
12. Devoted time spent to **physical therapy** after surgery ? _____ Months
13. How much time you think the situation took to **stabilize** (to be like this now) after surgery ?
    a. Less than 1 month ☐
    b. 1 to 3 months ☐
    c. 3 to 6 months ☐
    d. 6 to 12 months ☐
    e. More than 12 months ☐
14. **Assess your present condition** after as compared to before surgery

	Much better	Better	Same	Worse	Much worse
Facility in **general hygiene**					
Foot **pain**					
Sensivity (to feel the foot better)					
Comfort of the foot (cold, numbness)					
Voluntary control of the foot					
Balance					
Facility with **footwear use**					
Speed of walking					
Appearance and personal image					
Walking on the **stairs**					
Toes **wounds and calluses** and **ingrown toenail**					
Facility in **dressing**					
Amount of **daily march**					
Walking on **irregular floors or sand**					

15. **Evaluation of your gait** before and after surgery :

	Before surgery	After surgery
Do you have/had **frequent falls** ?		
You are/were able to use **public transportation ?**		
To **walk inside home** you need almost always : ○ Aid of another person ? ○ A support (cane, tripod or walker) ? ○ An ankle orthosis ?		
To **walk outside home** you need almost always : ○ Aid of another person ? ○ A support (cane, tripod or walker) ? ○ An ankle orthosis ?		

16. Now that you have passed the experience, do you think that your **life is improved** ?
g. Yes ☐
h. No ☐

17. If the previous answer was YES, try to evaluate from 1 (slight) to 5 (much) the **grade of improvement** :
_____

18. In relation to the **expectations** about the result of the surgery, you think that it :
Exceeded expectations ☐
Corresponded to that expected ☐
Was worse than expected ☐
Was disappointing ☐