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A novel surgical option for the operative treatment of clubfoot

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Clubfoot (*talipes equinovarus*) is a condition well known since the time of Hippocrates. Numerous conservative treatments have been introduced for this condition ; few are still in favour. Conservative treatment was used in our department up to the third month of age. The indication for surgery was failure to correct or maintain the correction after conservative treatment.

We report on 134 children (206 feet) who had operative treatment for clubfoot in our department during the period 1990-1996, using a novel surgical technique based on extensive posteromedial release combined with the lateral spread of the "extensor forces" of the foot. This new technique has produced excellent results.

INTRODUCTION

Clubfoot or *talipes equinovarous* is one of the most frequent congenital deformities of the foot. It is seen in approximately 1/1000 live births and the incidence rises to 1/20 (*5, 9, 17, 18, 23*) if there is genetic predisposition. The main deformities in this condition are : a) inversion and adduction of the forefoot, b) inversion of the heel and c) equinus fixation of the foot in plantar flexion at the ankle and subtalar joints.

Many conservative treatments have been proposed (*8, 9, 10, 13*) ; surgical treatment became an option when the principles of general anaesthesia were established. Numerous surgical procedures were used during the past sixty years for treatment of clubfoot and several are still in use (*11, 15, 21, 22*). About fifty to sixty percent of the children with clubfoot present with a fixed and rigid deformity after conservative treatment (*2, 4, 12*). Operation is indicated when conservative treatment fails to correct the deformity or when initially good results gradually fail, due to the persisting imbalance between the inverting and everting muscular forces. The first series of surgically treated patients and operative procedures appeared in the literature during the 1950s and 1960s (*3, 7, 10, 11, 12, 14, 20*). Turco (*19*) described such an operation in 1971 and published a monograph on the subject in 1981 (*20*). His approach and surgical technique seem to be favoured by most surgeons today.

The indications for surgical treatment nowadays are based on the severity and rigidity of the deformity (*6*). The impetus behind the design of this novel technique was that other techniques (which we have used in the department from 1972 to 1989) resulted in a high percentage of flatfoot deformities (up to 8%). We report a series of patients with a follow-up between 5 and 11 years who were treated with a new surgical technique and evaluate the

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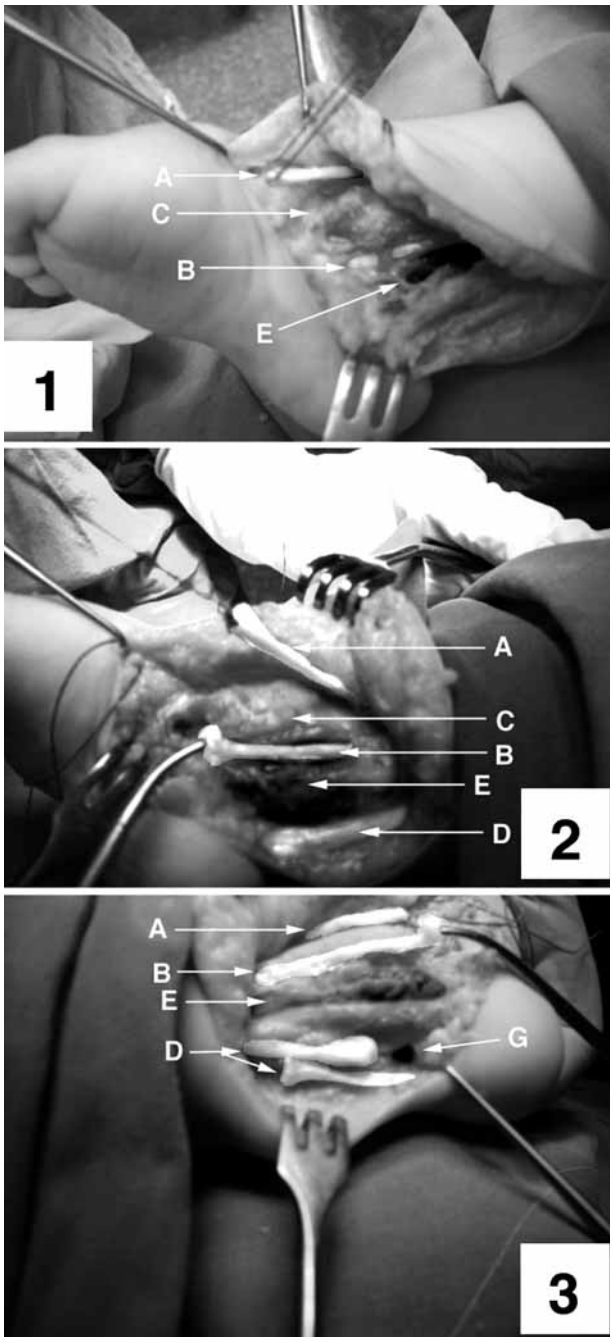

Fig. 1. — This series of photographs shows the first stages (1-3) of the surgical procedure.
(A) Anterior tibialis tendon, (B) Posterior tibialis tendon, (C) Medial malleolus, (D) Achilles tendon, (E) Neurovascular bundle.

results. The surgical technique used combines elements of previous methods in a novel way.

PATIENTS AND METHODS

Clinical Material

Between 1990 and 1996 134 patients with 206 clubfeet were treated surgically in our department. The congenital deformity was bilateral in 72 cases and unilateral in 62. In children with unilateral clubfoot, the deformity was on the right side in 22 and on the left side in 40. Eighty two children were male and 52 were female. Conservative treatment had failed in all cases. All patients were operated by the senior author or under his direct supervision using the same technique and the same postoperative management. The follow-up ranged from 5 to 11 years postoperatively.

Surgical technique

The surgical technique can be divided into the following stages :

1. Under general anaesthesia and with a thigh tourniquet, a deep incision is made along the Achilles tendon, curving under the medial malleolus and extending to the base of the first metatarsal along the medial side of the foot, and then turning dorsally to approach the middle of the second metatarsal bone. The skin incision is similar to the one described by Turco (*20*).
2. Using the surgical blade, the subcutaneous tissue and the fat layer are divided ; the skin is then detached as a full thickness flap, with blunt dissection (fig 1-2).
3. In this way all the anatomic elements are exposed (fig 1-1). A suture is passed through the insertion of the tibialis anterior tendon (fig 1-1, A).
4. Rolling the skin dorsally, the anterior and posterior tibialis tendons, the medial malleolous, the Achilles tendon and the neurovascular bundle are exposed (fig 1-2). The anterior and posterior tibialis tendons are detached from their insertions (fig 1-2, A, B).
5. The Achilles tendon is then completely exposed.
6. While protecting the neurovascular bundle a Z-type tenotomy of the Achilles tendon follows. With passive dorsiflexion of the foot, the two parts of the divided Achilles tendon are allowed to slide apart (fig 1-3, D). With the foot pushed into dorsiflexion, the posterior part of the capsule of the ankle joint is divided (fig 1-3, G) until full dorsiflexion can be achieved.

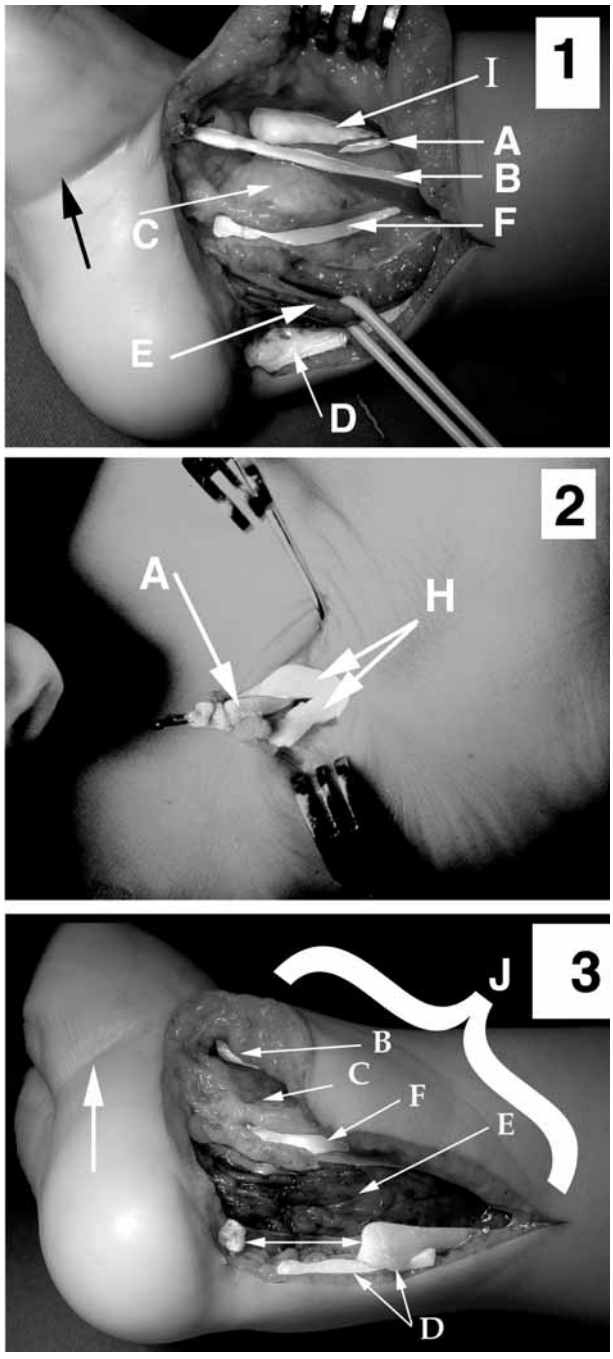

Fig. 2. — This series of photographs shows the last stages (1-3) of the operation.
(F) Flexor digitorum longus tendon, (G) division of the posterior capsule of the ankle joint, (H) Peroneus brevis tendon, (I) Extensor digitorum longus tendon, (J) Full thickness skin flap.

7. The tibialis anterior tendon is transferred laterally (fig 2-1, A). The tibialis posterior tendon is moved anteriorly to the medial malleolus and transferred to the insertion of the tibialis anterior, where it is fixed using a strong suture (fig 2-1B). To transfer the tibialis anterior tendon, a suture is passed through its distal end where it is clamped with a forceps and passed under the full skin flap to the lateral side of the foot. The peroneus brevis tendon is then prepared and split longitudinally. The tibialis anterior tendon is transferred laterally through the split in the peroneus brevis (fig 2-2 A, H). It is then sutured to the peroneus brevis tendon and then after making a loop, to itself. At this stage the rearrangement of the extensor forces is completed (fig 2-3).

The wound is closed without tension with interrupted skin sutures. Finally, a well padded above-knee plaster slab is applied.

Postoperative care

One week postoperatively the wound is checked and the back slab is exchanged to a full above knee-plaster of Paris cast (with the foot in dorsiflexion and valgus stress) under general anaesthesia. The plaster cast is removed 6 weeks later, and no further protection is used thereafter. It is not uncommon for the patients, whose age at this stages ranges from 5 to 6 months, to begin their first attempts at standing but no orthotic support is used. A regular postoperative follow-up every two months, up to the age of 14 months, is arranged.

Methods of evaluation

In this series, the severity of the deformity was the main variable between our patients. Our department's protocol employed the same pre-operative criteria and used the same conservative treatment for all our patients, so that prior treatment as well as the timing of operation was similar for all cases. The postoperative period for our review ranged between five and eleven years. Since the foot is almost molded by the age of four, when the longitudinal arch achieves its final configuration (*13*), the postoperative period for our review ranged between five and eleven years of age.

In assessing the results in this series, the aim was to obtain a complete and lasting correction and a pliable plantigrade foot in the shortest possible time. The evaluation was identical for both unilaterally and bilaterally affected feet, but in addition, unilaterally affected feet

were compared, clinically and radiographically, with the normal side (fig 3, 1-2). The method of evaluation for all cases was based on the following criteria :

1) Shape of the foot and postoperative existence of a flat foot deformity : The shape was evaluated by the heel cord alignment with the tibial axis and by obtaining the foot print. The latter was obtained by two methods : a) by painting the plantar skin with betadine and having the child stand on a white piece of paper and b) by taking a photograph of the child's foot as it was pressing on thick glass. The footprint is also valuable in order to exclude postoperative flatfoot deformity. The activity of the transposed tibialis anterior was evaluated.
2) Range of movement of both feet clinically and (when applicable) radiologically : in unilateral cases, the range of movement of the operated side was compared with the normal side. In cases with bilateral clubfoot the evaluation of the range of movement was in comparison with the 'normal' values as suggested by the AAOS *(1)*.
3) Radiological examination : This was only done after the patient reached skeletal maturity. Thus, only recently did we obtain the first radiographs of patients who were operated with this technique in 1990 and are now over 11 years of age. In all these cases radiographs (anteroposterior and lateral views) of both feet were taken. The radiological evaluation of the extension movement at the ankle joint was made using radiographs of both feet in the lateral view, with the feet in a full passive dorsiflexion.
4) Disability : The activities of the patient were checked with the help of a questionnaire which was designed to reveal any disability due to their congenital condition.
5) Need for further treatment conservative or surgical.

RESULTS

In this study we present 134 patients who were separated in two groups. Group 1 included the patients with unilateral clubfoot (62 patients), and group 2 the patients with bilateral deformities (72 patients, 144 feet).

In all cases of the unilaterally affected group the heelcord alignment with the tibia axis appeared to be normal. The shape of the foot in comparison with the unaffected side as it appears in the foot prints (fig 3-1) was near to normal except for the expected broadening of the forefoot. The comparison also revealed a slight torsion of the tibia, which did not cause any functional disturbance to the patients. The transferred tibialis anterior tendon appeared to be active in all these cases (fig 3-2). The movements of the operated foot in comparison with the function and range of movement of the unaffected side were slightly more limited in dorsiflexion but the differences were not significant. The comparative radiological measurements of passive dorsiflexion of the seven feet which were checked radiologically when the patients were over the age of eleven, shows a degree of limitation mainly in dorsiflexion on the affected side. No obvious radiological abnormalities were seen. The activities of the patients of this group were normal

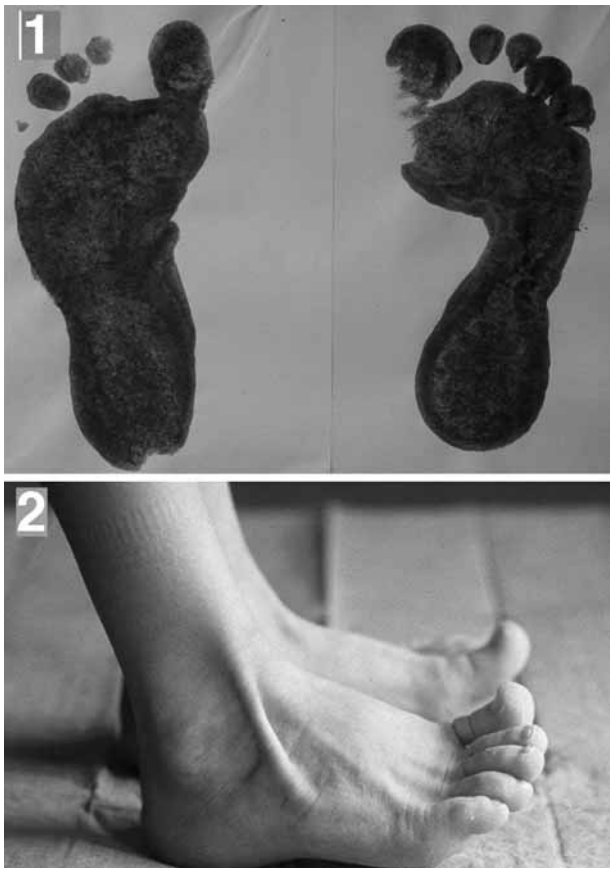

Fig. 3. — A unilateral clubfoot where the right side is affected, 11 years post-operatively. (1) the footprints ; (2) dorsiflexion of both feet shows the transferred tibialis anterior tendon.

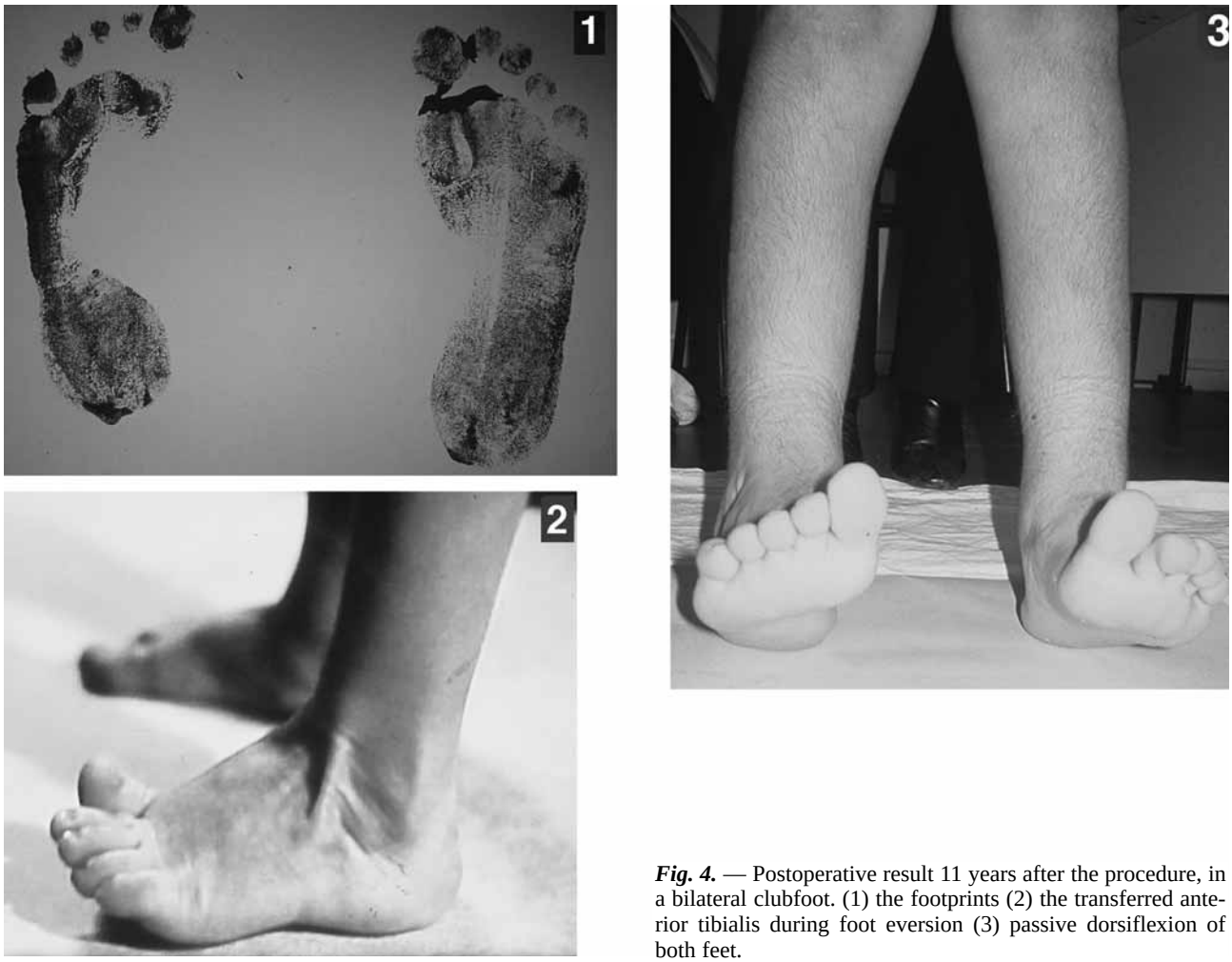

Fig. 4. — Postoperative result 11 years after the procedure, in a bilateral clubfoot. (1) the footprints (2) the transferred anterior tibialis during foot eversion (3) passive dorsiflexion of both feet.

and in accordance with their age at the time of follow-up. No patient was in need for any further treatment (surgical or conservative) after the initial operation. No patient needed an orthotic device at any stage.

The results of 144 operated feet in the 72 bilateral deformities of group 2 reveal that in 128 out of 144 feet, the shape was practically normal with no evidence of flatfoot. The footprints appeared to be normal even though there were slight differences in each pair (fig 4-1). The heel cord was aligned to the middle of the tibia axis and no callosities on the plantar side of the feet were noted. In addition, the transferred tibialis anterior tendon was still active (fig 4-2). We detected a considerable variation in restriction of the ankle joint movements. Flexion and extension of the ankle joint ranged from one-third of normal to half the normal range as defined by the AAOS (*1*) with dorsiflexion mostly affected (fig 4-3). The ten patients who had reached the age of 11 at the time of review and were checked radiologically showed some limitation of passive dorsiflexion, which approached 50% of normal. In the lateral radiographs, we noted a mild subluxation between the middle and hindfoot, mainly in the talonavicular joint. The significance of this cannot be fully appreciated at this stage. All these children participate actively in various athletic activities without any disability.

Complications

In two cases (four feet) both from group 2, a bilateral flat foot deformity developed at the second year of the patient's age and it progressed over time. It was located mainly at the hind part of the foot. A Grice-Green operation was performed at the end with satisfactory outcome.

In six cases (twelve feet) from group 2, the clubfoot deformity recurred 8-10 months postoperatively. The correction was lost and further treatment and surgery were necessary. In these cases measurement of the tibial torsion revealed slight internal rotation (mean 15°). External rotation osteotomy of the tibia in a slight extension (20°) was performed, which improved the biomechanics and the appearance of the foot. All patients were able to resume activities without the use of orthotic devises.

Fig. 5. — Anteroposterior and lateral radiograph of the distal tibia. The imprint of the transferred tibialis posterior tendon on the tibia shaft as it is seen 30 years postoperatively.

DISCUSSION

The literature on surgical management of clubfoot is extensive and there is considerable difference in opinions as to the indications for surgery and to the optimal procedure which is to be used (*16, 17*). It is generally agreed that, if surgery is necessary in young children, it should consist only of soft tissue procedures (*19, 22*).

Extensive posteromedial release as described by Turco, exposes most of the anatomic elements (anterior and posterior tibialis tendon, flexor hallucis longus and flexor digitorum longus tendons and the neurovascular bundle) except for the full length of the Achilles tendon. The approach can be used satisfactorily for posterior ankle and subtalar capsulotomy and the release of the middle and hindfoot. The lengthening of the heel cord requires some further exposure in order to avoid a separate surgical incision.

In clubfoot the main problem in all surgical procedures described so far is that they do not sufficiently address the tibialis posterior tendon, not only because of its underlying abnormality (*3, 7*) but also because the latter goes together with shortness of the flexor hallucis longus and flexor digitorum longus tendons. Anterior transfer of the tibialis posterior tendon laterally via the interosseous membrane is a generally accepted technique, which has been described with some variations. In most cases, the transferred tendon is very tight, which is probably the cause for the high incidence of postoperative flatfoot when utilising these techniques. The result of this tension can be seen (fig 5) in a radiograph of a patient who had operative treatment for clubfoot in our department at the time (1972-1989) when we routinely used the procedure described by Turco.

The new technique described in this paper was initially elaborated after extensive experience with the Turco technique. The advantages of the new technique are :

1) The posteromedial incision which we described gives a wide exposure.
2) The use of the tibialis anterior (instead of the tibialis posterior) and its transfer under the skin flap over the neurovascular bundle minimises the possibility of neurovascular damage. By using a thick fasciocutaneous flap, we ensure a good blood supply to the skin, minimising the risk of ischaemic necrosis.
3) Transposition of the tibialis posterior to the insertion of the tibialis anterior allows preservation of the dorsiflexion forces of the foot.
4) Transplantation of the tibialis anterior to the peroneus brevis tendon normalises dorsiflexion

and eversion.

5) The plaster cast is applied for only six weeks and no orthotic devices are required thereafter.

CONCLUSION

It has been our experience that the proposed surgical technique makes the clubfoot operation easier by simplifying the maneuvers. It also protects the neurovascular bundle and preserves the skin flap from ischaemia. Transposition of the posterior tibialis tendon to the anterior tibialis insertion normalises the dorsiflexion and eversion forces.

The low percentage of flatfoot (four feet in two children) in our series is related to the lateral transfer of the anterior tibialis tendon, instead of the shorter tibialis posterior tendon. The range of ankle movement achieved and the very low rate of complications in combination with satisfactory radiographs and minimal subsequent treatment demonstrate that this surgical technique has good long-term results.

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