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FUNCTION AFTER ANTEROLATERAL RESECTION OF THE LOWER LEG FOR EXTIRPATION OF TUMORS

Extension and Pronation of the Foot Restored by Transfer of the Tibialis Posterior Muscle

BJÖRN GUNTERBERG, GÖRAN MARKHEDE & BERTIL STENER

Departments of Orthopaedic Surgery II and Rehabilitation Medicine I, University of Göteborg, Göteborg, Sweden

A function preserving method for radical removal of tumors located anterolaterally in the lower leg is described. The loss caused by the inclusion of all extensors and pronators of the foot in the surgical specimen is compensated for, to a large extent, by transfer of the tendon of the tibialis posterior muscle to the conjoint tendons of the extensor digitorum longus and peroneus tertius. The function after such an operation has been studied in two patients using various methods including strength measurements and, in one of them, electromyography.

Key words: ankle joint; biomechanics; muscle resection; soft tissue tumors; surgical treatment

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A method for radical removal of soft tissue tumors located anterolaterally in the lower leg will be described. This procedure allows the preservation of a well functioning limb in certain cases in which the alternative treatment would be an above-knee amputation. The method has been used in two patients both of whom had undergone inadequate operations previously. The function, after the operation to be described, has been studied using various methods and will be reported here.

THE SURGICAL PROCEDURE

The skin incision is made so that all scars from previous operations, including the marks of the stitches, are included in the tumor specimen with an adequate margin. As soon as the epidermis and corium have been incised the knife is turned so that it cuts obliquely through the subcutaneous fat away from the scar region in all directions. When the anterior edge of the tibia has been reached the periosteum of the lateral tibial surface is separated from the bone and included in the specimen. Laterally, the superficial fascia of the leg is incised posterior to the fascia between the peroneal muscles and the soleus. Posteriorly, the whole fibula, except the lateral malleolus, and the whole interosseous membrane are included in the specimen. In this way, the previous surgical field, the tibialis anterior, extensor digitorum longus, extensor hallucis longus, peroneus longus and peroneus brevis muscles, the peroneal nerves, both the deep and superficial, and the anterior tibial vessels are removed *en bloc* with the tumor (Figure 1 right).

After removal of the specimen, a small skin incision is made where the tendon of the tibialis posterior muscle inserts into the navicular bone. Having been severed near its insertion, this tendon is then retracted and passed posteriorly over to the lateral side of the tibia where it is sutured to the conjoint tendons of the extensor digitorum longus and peroneus tertius.

Because a great deal of skin has had to be sac-

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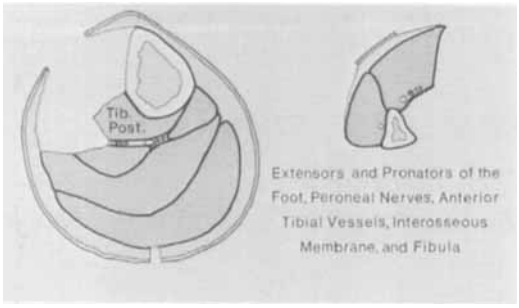

Figure 1. Surgical procedure.

rificed anterolaterally a posterior longitudinal midline incision is made through the skin, the subcutaneous layer, and the superficial fascia (Figure 1 left). The objective of this measure is to enable suturing of the long anterolateral wound without tension; primary healing is essential over the tendons which have been sutured to each other. The posterior wound is left open.

After conclusion of the operation the leg is put in a plaster bandage with the ankle joint in a neutral position and the foot plantigrade. The plaster bandage is worn for 6 weeks but the patient is allowed to walk with it after 3 weeks. The surgical procedure has been summarily described previously (Stener 1979).

PATIENTS

Patient 1. A 44-year-old woman was referred with a suspected local recurrence of a liposarcoma anterolaterally in the right lower leg. Prior to this, two inadequate operations for such a tumor had been performed (the first 10 years and the second 10 months previously). She had an 8 cm long palpable lump under a 20 cm long scar with broad stitch marks. The operation described above was performed in September 1971. (Somewhat more was removed than shown in Figure 1, viz, the anterolateral parts of the tibialis posterior muscle located in the »bay« between the fibula and the interosseous membrane). The postoperative course was uneventful. As early as 3 weeks after the operation she could extend her toes in the plaster bandage. The subsequent functional result will be described below. Unfortunately, a large retroperitoneal liposarcoma, detected in August 1972, eventually led to her death in May 1975.

Patient 2. A 47-year-old man was referred after having had an excisional biopsy of a tumor located laterally in the upper part of the left lower leg. The diagnosis was a liposarcoma of mixed myxoid and round-cell type. An operation as described above (Figure 1) was performed in January 1977. The postoperative course was uneventful. He is free of evidence of the disease at the most recent investigation in January 1980.

METHODS FOR EVALUATION OF FUNCTION

History of functional capacity. Information was obtained from records made 10 months postoperatively in Patient 1 and through questioning 3 years postoperatively in Patient 2.

Clinical examination. Data were gathered from the records of Patient 1 and through examination of Patient 2. The gait of the patients was studied. In Patient 1, a movie recorded 10 months postoperatively served well for this purpose (Figure 2).

Strength measurements. This was possible only in Patient 2. Maximal isometric dorsiflexion and plantar flexion torques were recorded on a dynamometer (Cybex II, Lumex, New York) with the ankle joint in neutral position. The technique is described elsewhere (Markhede & Nistor 1980). Measurements were made 4 months and 3 years postoperatively.

Figure 2. Sequence of pictures from a movie demonstrating Patient 1 walking barefoot. One picture has been omitted between each of those shown. Extreme right: stance phase of the non-operated leg.

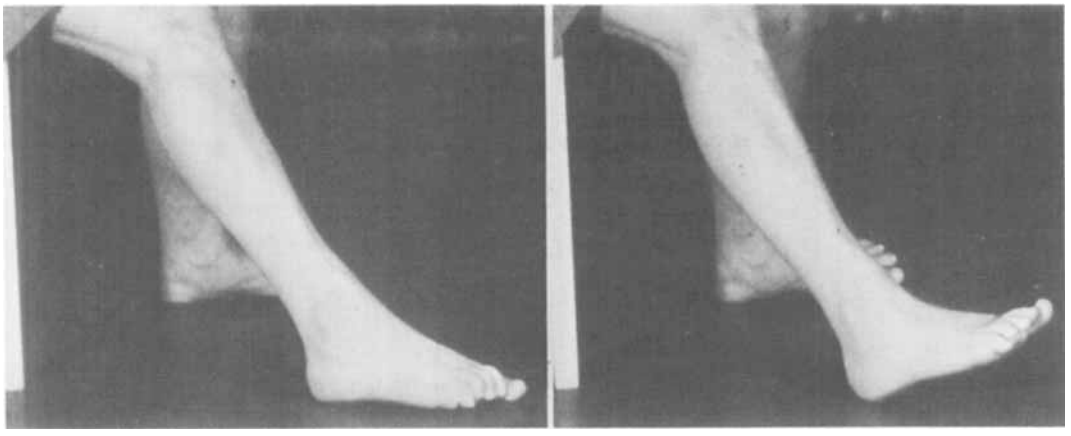

Figure 3. Patient 1 demonstrates active dorsiflexion of the ankle joint and ability to hold the foot in neutral position between supination and pronation. Note active extension also of the toes including the great toe.

EMG-recording of the transferred muscle. This was done in Patient 2 three years postoperatively. A needle electrode was inserted into the tibialis posterior muscle in its new position (easily palpated just lateral to the tibia). EMG was recorded in dorsiflexion and plantar flexion during maximal isometric contraction.

RESULTS

History of functional capacity

Subjectively Patient 1 walked quite normally when she used shoes with semihigh heels. Nor had she any difficulty walking without shoes even though her gait was then slightly affected. Patient 2 had a slight limp, and, using shoes with ordinary heels, he could walk a maximum of 5 kilometres, whereafter he experienced fatigue in the operated leg. His ability to run was significantly impaired. He could walk up and down stairs in a normal way but experienced slight unsteadiness when walking on uneven ground. Neither patient used walking support or experienced any pain.

Clinical examination

Patient 1 could actively dorsiflex the affected ankle joint even though she did not fully reach the neutral position between dorsiflexion and plantar flexion (Figure 3); while dorsiflexing the joint she could hold the foot neutral between supination and pronation. All five toes took part in active dorsiflexion indicating fibrous fusion of the extensor hallucis longus tendon to the other tendons that had been sutured to the tibialis posterior tendon. Patient 2 had an active range of motion on the affected side of between 0° of dorsiflexion and 10° of plantar flexion (normal side 20 and 30°, respectively). All five toes took part in the dorsiflexion movement. Patient 2 could hold the foot plantigrade but could not pronate it further from this position. The circumference of the operated leg was 5 centimetres smaller than that on the non-operated side. A movie revealed that Patient 1 limped slightly while walking barefoot because of her inability to dorsiflex the foot fully on the operated side (Figure 2); however when she walked with semihigh heels there was no visible limp. In Patient 2, a slight limp was noticeable both when he walked barefoot and when he had shoes with ordinary heels. However, like Patient 1, he managed well without any extension orthosis for the foot.

Strength measurements

The results are given in Table 1. The dorsiflexion strength on the non-operated side (right) was about the same in the two recordings, but on the operated side (left), there was both a relative and an absolute decrease in strength 3 years postoperatively compared with 4 months postoperatively. Three years postoperatively, the

Table 1. Muscle strength recordings (Nm) in Patient 2. The tibialis posterior muscle is the only dorsiflexor on the left side

	Dorsiflexion		Plantar flexion	
	4 months postop	3 years postop	4 months postop	3 years postop
Right	39.3	42.5	147.6	157.5
Left	21.4	12.5	126.2	112.5
Percentage	55	30	86	71

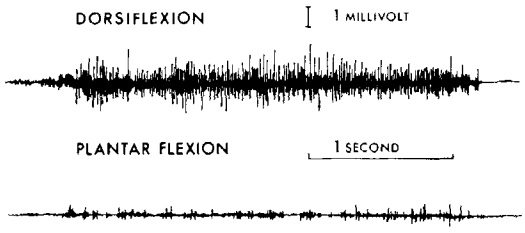

Figure 4. Patient 2. Electromyography of the transferred tibialis posterior muscle during maximal isometric dorsiflexion and plantar flexion of the ankle joint.

tibialis posterior muscle compensated for about one-third of the lost dorsiflexion torque and the plantar flexion torque was reduced by about 30 per cent.

EMG-recordings of the transferred muscle

The results are shown in Figure 4. There was very little activity during plantar flexion whereas the EMG-activity was nearly normal in dorsiflexion.

DISCUSSION

This limb saving method for radical removal of tumors located anterolaterally in the lower leg has been briefly described earlier (Stener 1979) but it has not been discussed before. The method implies complete removal of two of the four muscle compartments of the lower leg along with the whole fibula except the lateral malleolus, resulting in total loss of active dorsiflexion and pronation of the foot. The function can be satisfactorily restored by transfer of a single muscle – the tibialis posterior. As the interosseous membrane has been removed this can be done easily: no tissues have to be passed through by the transferred muscle whose distal insertion is simply exchanged from the navicular bone to the conjoint tendons of the extensor digitorum longus and peroneus tertius. Actually, the bulk of the muscle is located postero-*lateral* to the tibia (Figure 1) so it is easy to redirect its tendon from the medial to the lateral side.

When the strength generated by the tibialis posterior muscle in its new position was measured in Patient 2 four months postoperatively, the dorsiflexion torque corresponded exactly to the loss of plantar flexion torque (the levers are about the same). Three years postoperatively, it had for some reason decreased. However, the tibialis posterior was still able to compensate for about one-third of the strength that had been lost by removal of all the dorsiflexors of the ankle joint, and this was sufficient for holding the foot plantigrade and thereby reducing functional impairment to an acceptable level.

The EMG study showed that the transferred muscle had almost completely altered its function from being a flexor to being an extensor of the ankle joint: very little activity was registered in the muscle during active plantar flexion. As the patient could hold the foot plantigrade the tibialis posterior obviously also served as a pronator, compensating for the loss of the peroneus longus and brevis muscles.

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Correspondence to: Björn Gunterberg, M. D., Department of Orthopaedic Surgery, Sahlgren Hospital, S-413 45 Göteborg, Sweden.