INTEROSSEOUS TRANSFER OF TIBIALIS POSTERIOR FOR COMMON PERONEAL NERVE PALSY

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The interosseous route remains popular for tibialis posterior tendon transfer for drop-foot. It leaves a smaller range of movement than the circumtibial route, but lengthening the calcaneal tendon may improve this. The results of this present series indicate that, in order to predict a good functional result, the ankle must be held in at least 20° of dorsiflexion at the time of tendon transfer.

Transfer of the tibialis posterior is indicated for supinated equinovarus deformity of the foot in which the muscle is a deforming force, and therefore especially suitable for transfer to act as an active dorsiflexor. The operation aims to improve gait by providing an active balanced transfer which will obviate the need for a foot-drop splint, or for a posterior bone block (Ingram 1987). Some surgeons consider the transfer to be no more than a tenodesis, but an active range of 15° to 30° of dorsiflexion is reported in most series (Anderson 1964; Srinivasan, Mukherjee and Subramanium 1968; Warren 1968; Malaviya 1981).

The purpose of this paper is to review the literature and to analyse the results in a series of tibialis posterior transfers in patients with leprosy.

PATIENTS AND METHODS

From 1983 to 1985, tibialis posterior transfer was performed at Green Pastures Leprosy Hospital, Pokhara, Nepal on 39 legs of 29 patients aged 11 to 61 years. All the patients had had leprosy, with complete common peroneal nerve palsy causing drop-foot, for more than one year. The duration ranged from 1 to 14 years (mean 4.5 years). There were 21 males and 8 females, reflecting the sex ratio for the prevalence of leprosy in Asia. Age was no contra-indication to operation, provided the patient was sufficiently motivated and intelligent to learn how to use the transferred tendon. All the operations were performed by the author.

Each patient was managed by the same two physiotherapists before and after the operation; they taught the patient how to contract tibialis posterior independently. Its power had to be MRC grade 4+ or 5 before transfer (Turner and Cooper 1972). Patients with passive dorsiflexion of less than 20° had lengthening of the calcaneal tendon at the same time as the transfer. Patients with other fixed deformities or instability requiring bone surgery were excluded from the series.

Operative technique. The technique is that of Watkins et al (1954), except for the method of fixing the transferred tendon. Through a medial incision, the tendon is divided at its insertion to the navicular and mobilised above the medial malleolus. A second incision is made parallel and lateral to the lower third of the tibial crest, and a long incision is made through the interosseous membrane. Using a blunt tendon tunneller and gentle traction the muscle belly of tibialis posterior is then delivered into the anterior compartment of the leg.

The tendon is then split longitudinally into two 'tails' (Srinivasan et al 1968); the medial tail is inserted into the tendon of extensor hallucis longus and the lateral tail into the tendons of extensor digitorum longus and peroneus

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At the end of the operation the foot is removed from the splint and, with the knee at 90° flexion the 'release angle' of the foot is measured (see text).

![Diagram of Release Angle](image)

**Table I.** Mean range of ankle movement related to the maximum active dorsiflexion achieved by the transfer in 39 limbs

<table>
<thead>
<tr>
<th>Active dorsiflexion*</th>
<th>Number of limbs</th>
<th>Mean range of movement*</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;15</td>
<td>2</td>
<td>22.5</td>
</tr>
<tr>
<td>10 to 15</td>
<td>15</td>
<td>19.1</td>
</tr>
<tr>
<td>5 to 9</td>
<td>15</td>
<td>14.8</td>
</tr>
<tr>
<td>0 to 4</td>
<td>5</td>
<td>12.5</td>
</tr>
<tr>
<td>&lt;0</td>
<td>2</td>
<td>17.0</td>
</tr>
</tbody>
</table>

*In degrees

**Table II.** Mean active dorsiflexion achieved by the transfer related to the release angle at the time of tendon fixation

<table>
<thead>
<tr>
<th>Release angle*</th>
<th>Number of limbs</th>
<th>Mean active dorsiflexion*</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 to 20</td>
<td>1</td>
<td>12.0</td>
</tr>
<tr>
<td>11 to 15</td>
<td>5</td>
<td>7.8</td>
</tr>
<tr>
<td>6 to 10</td>
<td>12</td>
<td>7.0</td>
</tr>
<tr>
<td>1 to 5</td>
<td>18</td>
<td>6.2</td>
</tr>
<tr>
<td>-4 to 0</td>
<td>3</td>
<td>6.0</td>
</tr>
</tbody>
</table>

*In degrees

**Table III.** Mean release angle related to the active dorsiflexion achieved

<table>
<thead>
<tr>
<th>Active dorsiflexion*</th>
<th>Number of limbs</th>
<th>Mean release angle*</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;15</td>
<td>2</td>
<td>8.0</td>
</tr>
<tr>
<td>10 to 15</td>
<td>16</td>
<td>7.7</td>
</tr>
<tr>
<td>5 to 9</td>
<td>14</td>
<td>7.0</td>
</tr>
<tr>
<td>0 to 4</td>
<td>5</td>
<td>2.0</td>
</tr>
</tbody>
</table>

*In degrees

tertius. Using a metal splint (Fritschi 1971), the knee is held flexed to approximately 90° and the ankle in dorsiflexion of at least 20° (Fig. 1). Tendon suturing is completed with the leg in this position, so that the tension on the two tails is equal; this avoids the development of varus or valgus deformity.

After tendon suture, the foot is gently removed from the splint and, with the knee still held at 90°, the foot is allowed to assume a position of rest. The angle of dorsiflexion is measured and recorded as the release angle (Fig. 2). After skin suture, a below-knee plaster is applied, with the foot further dorsiflexed to release any tension on the tendon sutures during healing. The patient remains in plaster for four weeks, but is allowed to walk and weight-bear after the first week. Re-education out of plaster is reinforced by visual feedback, the patient walking towards a mirror. In most cases a heel–toe gait is attained within a few weeks.

For the assessment of results two criteria were used:
1) the maximum angle of active dorsiflexion at the ankle;
2) the range of movement of the foot.

Measurements were taken with the patient sitting and the knee extended, using a goniometer.

**RESULTS**

At the time of tendon suture the angle of dorsiflexion of the foot on the metal splint ranged from 10° to 25° (mean 17°). At the end of the operation the release angle ranged from 1° to 18° (mean 8°), giving a mean difference of 9° between the splint and release angles.

All angles were measured to the nearest degree, but for the purpose of correlation, the results were grouped. Table I gives the maximum active dorsiflexion achieved and the range of movement in each group. Surgery can be considered successful if active dorsiflexion above the neutral position is achieved; this was attained in 37 of 39 limbs (94.9%). There is also a tendency for the range of movement to increase with increasing active dorsiflexion. The two patients with no active dorsiflexion both had complications. One, a 35-year-old woman, had a wound infection; the foot went into equinus of $-10°$ at rest, with only a 12° range of movement. The other, a 50-year-old man, had a release angle of 6°, but rapidly developed equinus after operation and had no active dorsiflexion. His transfer was probably non-functional because of injury to the posterior tibial nerve. These two patients are excluded from the rest of the results.

Tables II and III relate the mean active dorsiflexion achieved to the release angle at the time of tendon suture. It is clear from both tables that there is a positive correlation.

Of the 39 limbs, 14 required a lengthening of the calcaneal tendon to allow passive dorsiflexion of at least 20° in the splint. There was no significant difference in the duration of common peroneal nerve palsy between those requiring lengthening and the others.
DISCUSSION

The aim of tibialis posterior transfer in these cases is to restore a normal heel–toe gait. Success depends on a surgical technique which maximises the potential of the transfer and on the re-education of the patient to use active dorsiflexion during the swing phase of gait. This new pattern of use must become centrally integrated.

As regards operative technique this series has shown that the angle of dorsiflexion at rest at the completion of the operation (release angle), is 10° less than the angle set by the splint. Therefore a higher splint angle at operation will give a greater degree of active dorsiflexion. To obtain a splint angle of over 20°, percutaneous or open lengthening of the calcaneal tendon is needed. Indeed it may be advisable to perform a percutaneous lengthening in all patients. Hall (1977) noted a 10° loss of resting angle and active dorsiflexion over two years, only in patients who did not have lengthening.

The interosseous route remains popular for tibialis posterior tendon transfer (Miller et al 1982), but results are usually defined functionally and somewhat subjectively (Watkins et al 1954; Gunn and Molesworth 1957; Turner and Cooper 1972; Miller et al 1982). Only two series give objective clinical data: Hall (1977) and Malaviya (1981) described postoperative angles of active dorsiflexion and range of movement and correlated them with functional results. Malaviya (1981) reported 98 limbs in which a circumtibial route was used; 68 (69%) had good heel–toe gait at one year. He correlated this with objective measurements of active dorsiflexion, finding that those with a fully restored heel–toe gait, had a mean dorsiflexion of nearly +5°, while the failures had –5°.

Of the 32 feet I report, 82% achieved adequate active dorsiflexion but their range of movement was not as good as that reported for the circumtibial route (mean ranges 16.7° and 20°) (Malaviya 1981). Hall reported 25° to 30° for the circumtibial route and 17° for the interosseous route. However in my series, the mean range of active plantarflexion before operation was 26°, postoperatively 10°. This suggests that the transfer acts to some extent as a tenodesis; the poorer range of movement compared with circumtibial route is probably due to adhesions in the interosseous space.

To obtain a reasonable result, it seems that the tendon transfer should act partially as a tenodesis. This is disappointing and is useful to explore possible explanations. The anteriorly-transferred tibialis posterior becomes the prime mover for active dorsiflexion. During heel–toe gait, no antagonistic muscles contract while the foot is dorsiflexed, but at rest the tibialis posterior has to provide an equal and opposite force to the other muscles plantarflexing the ankle.

That the plantarflexors are stronger is shown by the loss of 10° of both active dorsiflexion and rest position in the first year after operation (Anderson 1964; Srinivasan et al 1968; Hall 1977). The use of a subcutaneous tunnel for the transfer creates a long moment arm for the joint (Fig. 3). This increases the mechanical advantage for power, but means that the tendon excursion is used up faster, allowing a smaller range of movement (Brand 1974). The tibialis posterior has an excursion of only 2 cm whereas the dorsiflexors it replaces (tibialis anterior and extensor hallucis longus) have excursions of from 3 to 5 cm (Biesalski and Mayer 1916). Thus the long moment arm and the short excursion contribute to the less than normal range of movement at the ankle.

Another factor is the tension put on the transfer at the time of tendon fixation. Physiologically, tendon fixation should take place with the foot in the resting, neutral position with sufficient passive tension on the transferred tendon to stretch it out to its ‘resting length’. This will allow the tendon to generate the maximum active tension in contraction (Fig. 4). If the tension is greater than that necessary to achieve a resting length,
then there is a rapid fall off in total tension achieved, and the transfer acts more like a tenodesis than an active transfer.

Many surgeons continue to fix the transfer into an osseous tunnel in the lateral cuneiform. This has two disadvantages: first, it has been shown to increase the likelihood and severity of neuropathic arthropathy of the tarsal joints in predisposed patients (Anderson 1964; Harris and Brand 1966; Warren 1968). Secondly, the fixation point is critical in ensuring that there is no tendency for later inversion or eversion deformity. The tendon-to-tendon technique of Srinivasan et al (1968) obviates these problems, allowing the surgeon to adjust the tension on the two tails appropriately.

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REFERENCES


