LAMBRINUDI TRIPLE ARTHRODESIS FOR CORRECTION OF SEVERE RIGID DROP-FOOT

S. C. TANG, J. C. Y. LEONG, L. C. S. HSU

From the University of Hong Kong

The results of 10 patients with severe rigid drop-foot corrected by the Lambrinudi triple arthrodesis were studied. The average amount of correction was 47 degrees, as evaluated from standing radiographs taken before and after operation. Radiological features of osteoarthritis and of flattening of the talus were common, but the feet were painless when reviewed at an average of 70 months later. A satisfactory range of movement was obtained at the ankle joint.

In 1927 Lambrinudi described a triple arthrodesis for the correction of the drop-foot deformity (Lambrinudi 1927, 1933). In severe examples the talus is in a plantarflexed position and further plantarflexion of the foot is prevented by the posterior process of the talus abutting against the back of the ankle. Paralytic drop-foot consists of two types. The first type occurs in a flail foot when, because of the absence of muscle power around the ankle, the foot drops due to the effect of gravity. The equinus is usually not severe, and is easily passively correctable to a plantigrade position. The

![Diagram showing normal geometric relationship between the longitudinal axes of the tibia, first metatarsal and os calcis.](image1)

![Diagram showing a severe equinus foot.](image2)

Figure 1—Schematic diagram showing the normal geometric relationship between the longitudinal axes of the tibia, first metatarsal, and os calcis. Figure 2—In severe equinus deformity, the longitudinal axis of the tibia will not meet that of the first metatarsal proximally, and the TM angle will be greater than 180°. (TM, tibiometatarsal angle; MC, metatarsocalcaneal angle; TC, tibiocalcaneal angle.)

The lower end of the tibia. The Lambrinudi operation makes use of this mechanism, the forefoot being brought up into a plantigrade position and fused with the hindfoot.

results of the Lambrinudi procedure in this type of deformity are generally good, but loss of correction can develop during follow-up because of stretching of the ligaments around the ankle, which occurs gradually after the triple arthrodesis.

The second type is a fixed, rigid equinus, and occurs when there is imbalance between the dorsiflexors and plantarflexors of the ankle. The equinus is often severe, so that the foot forms an angle of 180 degrees or more with the longitudinal axis of the tibia. The patient then
walks on the metatarsal heads, and the metatarsophalangeal joints become dorsally subluxated. In performing a Lambrinudi procedure for these feet, a lot of the talus has to be removed to achieve correction of the deformity. A search of the literature reveals that little has been written about the role of the Lambrinudi procedure in these very severe rigid equinus feet. Between 1969 and 1980, 10 patients with such deformities were operated on in the Duchess of Kent Children's Hospital, Hong Kong, using the Lambrinudi procedure. The purpose of this paper is to evaluate the results and problems in these patients.

![Fig. 3](image1.png)  
**Fig. 3**—Standing lateral radiograph of the ankle region of a normal individual, with TM angle measuring 110 degrees.  
**Fig. 4**—Standing lateral radiograph of the ankle region of a patient with severe rigid equinus deformity: the TM angle measures 213 degrees.

**MATERIALS AND METHODS**

We assessed the degree of equinus deformity by taking a lateral radiograph of the ankle region with the patient standing, and measured the obtuse angle, which we called the TM angle, subtended between the longitudinal axis of the tibia and that of the first metatarsal. As the degree of equinus deformity increased, the TM angle would correspondingly increase (Figs 1 and 2). The TM angle of the feet of normal adults in a standing posture averaged 110 degrees (Fig. 3). In the 10 patients under study, eight had TM angles exceeding 160 degrees, and the remaining two had TM angles between 140 and 160 degrees (Fig. 4). Of the 10 patients, nine were male. The age at operation ranged from 14 to 24 years (average 18.7 years). Eight of them were affected by poliomyelitis, one was suffering from Charcot–Marie–Tooth–Hoffmann syndrome, and the remaining one had Friedreich's ataxia. Nine patients had a follow-up period exceeding four years and the remaining patient two years and eight months (average 69.3 months, maximum 8.5 years).

**Surgical technique.** Kocher's transverse lateral incision was used in four patients, and a vertical incision in six patients, to allow a lateral approach to the subtalar joint. Internal fixation was carried out in all patients using staples, and five patients had an additional cancellous bone graft taken from the resected talus.

**Postoperative management.** Plaster immobilisation of the corrected deformity was used after operation. Seven patients had below-knee casts alone, one had a long-leg cast alone, and the remaining two patients had long-leg casts followed by below-knee casts. Weight-bearing was started when the radiograph showed that bony union was progressing.

**RESULTS**

**Objective assessment**

Objective assessment included the degree of residual deformity by measuring the TM angle, specific radiological changes, the range of movement at the ankle, instability of the ankle, and the presence of callosities.

**Residual deformity.** Table I shows the values of the TM

<table>
<thead>
<tr>
<th>Case</th>
<th>Before operation</th>
<th>After operation</th>
<th>Correction obtained</th>
<th>Loss of correction</th>
<th>Angle at follow-up</th>
<th>Final correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>228</td>
<td>125</td>
<td>103</td>
<td>17</td>
<td>142</td>
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<tr>
<td>2</td>
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<td>154</td>
<td>19</td>
<td>0</td>
<td>154</td>
<td>19</td>
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<td>106</td>
<td>64</td>
<td>0</td>
<td>106</td>
<td>64</td>
</tr>
<tr>
<td>4</td>
<td>213</td>
<td>134</td>
<td>79</td>
<td>9</td>
<td>143</td>
<td>70</td>
</tr>
<tr>
<td>5</td>
<td>163</td>
<td>153</td>
<td>10</td>
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<td>153</td>
<td>10</td>
</tr>
<tr>
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<td>143</td>
<td>117</td>
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<td>0</td>
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<td>26</td>
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<tr>
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<td>136</td>
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<td>136</td>
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<tr>
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<td>119</td>
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<td>199</td>
<td>122</td>
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<td>0</td>
<td>122</td>
<td>77</td>
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<td>177</td>
<td>126</td>
<td>51</td>
<td>0</td>
<td>126</td>
<td>51</td>
</tr>
</tbody>
</table>

Average degree of correction: 47 degrees  
Two patients had loss of correction as measured at follow-up visit (Cases 1, 4)

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Range of movement at the ankle. Assessment of these patients before the operation showed that they all had less than 10 degrees of movement at the ankle. At follow-up all of them had some active movement whose range varied from 5 to 50 degrees (Table II).

**Instability.** No patient had clinical instability of the ankle at the last follow-up.

<table>
<thead>
<tr>
<th>Case</th>
<th>Range of movement of ankle</th>
<th>Absolute movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 to 40</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>10 to 40</td>
<td>30</td>
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<tr>
<td>3</td>
<td>5 to 25</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>20 to 50</td>
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<tr>
<td>5</td>
<td>10 to 50</td>
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<td>30</td>
</tr>
<tr>
<td>10</td>
<td>5 to 10</td>
<td>5</td>
</tr>
</tbody>
</table>

The neutral position of the ankle is designated as 0 degrees. A positive value indicates the degree of plantarflexion, while dorsiflexion is given a negative value.

Angles of the patients under study. All achieved correction of their equinus deformity. The last column in Table I shows the final amount of correction obtained, which averaged 47 degrees, with 86 degrees as the maximum. Loss of correction of 17 and 9 degrees occurred in two patients, Cases 1 and 4 respectively.

The clinical course of one patient is shown in Figures 5 and 6 and the general appearance of the foot before and after operation in Figures 7, 8, 9 and 10.

**Radiological changes.** Flattening of talus (Ingram and Hundley 1951) was present in seven patients (Fig. 11).

The changes of osteoarthritis in the ankle were shown by the presence of a narrowed joint space in five patients, and subchondral sclerosis or cyst formation in two patients; tarsal osteoarthritis was shown by dorsal lipping of the tarsal bones in four patients. Radiological features of osteoarthritis occurred in eight patients in all. No radiological evidence of pseudarthrosis occurred in the present study.

A patient with severe rigid equinus deformity of the right ankle. Figure 7—AP view. Figure 8—Lateral view. Figure 9—AP view after operation. Figure 10—Lateral view after operation.
Subjective assessment

All patients were questioned about their exercise tolerance, about fitting of footwear, whether they had any residual pain and also whether the operation as a whole had been worthwhile.

Exercise tolerance and footwear. Five patients showed an improvement in exercise tolerance after operation (two could actually go hiking), while exercise tolerance in the rest remained unchanged. All patients had had difficulty in using ordinary footwear before the operation because of their deformity, but all of them could use ordinary footwear afterwards.

Pain. Before operation five patients had pain in the foot that limited their walking range. After operation none of them had significant subjective pain or pain which affected their daily activities. Three had vague aches and discomfort, especially with changes of weather.

General satisfaction. All patients were satisfied with the overall results of the operation.

Functional assessment. Functional assessment of the results of the operation was according to the criteria set down by Hallgrimsson (1943) and MacKenzie (1959). Five patients had good overall results, and the remaining five was classified as fair. No failure occurred in the present series.

DISCUSSION

Most series reporting the results of the Lambrinudi triple arthrodesis for paralytic drop-foot do not separate these feet into the flail and rigid varieties. We feel that the patients in this small series represent a particularly difficult problem. First of all, the degree of equinus deformity is extreme, so much so that the longitudinal axis of the foot is often a continuation of the longitudinal axis of the tibia. Secondly, these patients had little or no movement at the ankles at the time of their presentation. Thirdly, many of them presented because of increasing difficulty in walking, either because of pain at the metatarsal heads or in the metatarsophalangeal joints, or because of difficulty in obtaining footwear.

In using the Lambrinudi triple arthrodesis in an attempt to achieve a plantigrade position, much of the talus had to be removed, together with resection of a big wedge of bone in the subtalar joint. This may lead to the two problems of a possible avascular necrosis of the talus and shortening of the foot. In this study, seven of 10 patients had some degree of flattening of the talus on radiological examination. However, whether they had true avascular necrosis was not known. There was no pain at the ankle joint at an average follow-up period of seventy months. It would appear to us that the radiological appearance was unimportant if the foot could be corrected to a nearly plantigrade position, if the patients could wear normal shoes, and if they retained a certain degree of movement at the ankle. No patient complained of shortening of the foot, possibly because the feet had originally been so deformed. If flattening of the dome of the talus is an indication of avascular necrosis, as believed by some (Ingram and Hundley 1951), these patients are likely ultimately to develop osteoarthritis of the ankle joint with pain. The longest follow-up in this series was eight and a half years, and the patient had no pain. If significant pain does occur later, then fusion of the ankle could be carried out as a salvage procedure. It should be noted that all these feet had less than 10 degrees of movement at the ankle when they first presented.

Most series (Bernau 1977; MacKenzie 1959) adopt the functional grading of Hallgrimsson (1943) and MacKenzie (1959) by separating the patients into the four groups of, ideal, good, fair and failure. In this study, an attempt has been made to assess the degree of correction of the deformity objectively by measuring the TM angle, and comparing the value at final follow-up with the preoperative value. The average amount of correction was 47 degrees. Thus it could be seen that the Lambrinudi method of triple arthrodesis corrected the severe rigid equinus deformity to a significant extent.

Loss of correction occurred in two out of 10 patients. The maximal loss was 17 degrees, as compared to that of 20 degrees (Tschui 1962) and 35 degrees (Bernau 1977) reported by other authors. Our patients had very severe equinus deformity before surgery.

The highest rates of pseudarthrosis were reported in the study by Patterson, Parrish and Hathaway (1950) as 33 per cent and by MacKenzie (1959) as 17 per cent. In the great majority of cases non-union occurred in the talonavicular joint. Bernau (1977) reported pseudarthrosis occurring in two out of 50 feet, also in the
talonavicular joint. In the present study there was no pseudarthrosis. Radiological changes suggestive of osteoarthritis occurred in eight patients (80 per cent) as compared to 15 per cent in MacKenzie's study (1959). However, in the present series there was no correlation between radiological osteoarthritic changes and the presence of pain. Instability at the ankle had been ascribed to technical error in the arthrodesis by Fitzgerald and Seddon (1937); this phenomenon did not occur in the present study. A small amount of residual equinus was present in seven patients, but none complained of this, probably because it compensated for their short leg to some extent.

These results demonstrate that the Lambrinudi procedure is a useful method for dealing with these severe rigid equinus deformities, because it can result in a painless foot, with significant correction of the deformity, and an increase in the range of movement at the ankle.

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REFERENCES

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