Lateral ligament reconstruction of the ankle: comparative study of peroneus brevis tenodesis versus periosteal ligamentoplasty

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Summary
Lateral chronic instability of the ankle represents 10–30% of ankle sprain sequellae. This study compares the results of two procedures: peroneus brevis tenodesis (PBT) and periosteal flap graft (PFG). The two series were composed by: 24 PBT, 22 PFG; all patients practiced sports and 59% were competitors. The mean follow-up is 5.5 years for the PBT and 3 years for the PFG. The results were evaluated both clinically (according the functional rating scale of Good–Jones–Livingstone) and radiologically with pre- and postoperative stress tests (talar tilt, anterior drawer test). Sports resumption evaluation was also recorded. These results show better functional outcome for the periosteal procedure (91% success rate) compared to the peroneus brevis procedure (54% success rate). Functional results were statistically correlated (Fischer's test) with stability improvement evaluated on radiological stress test. Clinical outcome discrepancies may be explained by a biomechanical perspective: anatomical reconstructive procedure of the anterior talofibular ligament is a better technique to preserve the talar joint adaptative function.

Keywords: ankle instability; ankle lateral ligament reconstruction; periosteal ligamentoplasty; peroneus brevis tenodesis

Introduction
Lateral ankle sprain is a common injury. It has been estimated that there is about one inversion injury of the ankle per 10 000 persons per day [1]. Ankle sprains account for 25–50% of injuries in sports and athletics [2–4]. Chronic lateral ankle instability represents 10–30% [5–7] of ankle sprain sequellae which can severely impair sports performance. This type of instability implies lesions of the fibular lateral ligament complex and specifically the anterior talofibular ligament which acts as the primary restraint for the ankle at all angles of flexion [8, 9]. Mechanical and functional instability may be parallel phenomena but they are not strictly correlated [6, 10]. More than 50 reconstructive procedures for ankle ligamentoplasty have been described using: direct suture or reinsertion of torn ligaments; capsular shift [11–14]; ligamentoplasties with the peroneus brevis tendon [3, 15–18]; the inferior retinaculum extensor...
The aim of this retrospective study is to compare two procedures: (1) a tenodesis with the peroneus brevis tendon (PBT) as described by Castaing [15, 23]; (2) an anatomical reconstruction of the anterior talofibular ligament with a periosteal flap graft (PFG) [24] which has recently gained popularity [25–29].

Materials and methods

Patients

This retrospective study includes 46 patients who underwent lateral ligamentous reconstructive procedures of the ankle.

Twenty-four consecutive patients (15 men and nine women) aged 15–44 years (mean 27), were treated with PBT. The mean delay between the initial episode of ankle sprain and the operation was 4 years (range, 3 months–15 years). Thirteen patients practised competition sports and 11 recreational sports.

Twenty-two consecutive patients (13 men and nine women) aged 14–41 years (mean 21), were treated with PFG. The mean delay between the initial injury and the operation was 6 years (range, 2 months–17 years). Fourteen patients practised competition sports and eight recreational sports.

The majority of the patients recalled several ankle sprains (a mean of 3) leading to chronic instability and functional impairment in athletic activities and/or social life. Soccer was the most frequently concerned sport (Figure 1).

There was no difference in the treatment of the initial accident between the two groups: for the majority of cases, initial treatment included plaster cast (with a mean duration of immobilization of 3 weeks) followed by a rehabilitation programme. However, a remarkable number of ankle sprains remained medically untreated (19/46).

Surgical protocols

Peroneus brevis tendon. A conventional lateral approach is used: the peroneus brevis is released and severed in its proximal part so as to free the distal 15 cm of the tendon (the muscular part is sutured to the peroneus longus). Then a tunnel is drilled perpendicularly in the distal part of the lateral malleolus. The tendon is passed from back to front in this tunnel and sutured to itself with the foot in neutral position. The sutures are progressively tightened so as to obtain an optimal tension of the graft (Figure 2).

Periosteal flap graft. The procedure is performed through a lateral approach with a more proximal extension. Care should be taken with the superficial fibular nerve. The lateral malleolus and the neck of the talus are then exposed. The fibular periosteum is dissected with a rasp to at least 1 cm width and 12 cm length, then a tunnel is vertically drilled through the talar neck. The graft is secured by a suture at its distal insertion to the periosteum of the anterior border of the lateral malleolus. The graft is then

Figure 3
Periosteal ligamentoplasty (Roy-Camille-Saillant procedure). The periosteal flap is individualized; its distal malleolar insertion is preserved. The graft is then passed through the transosseous tunnel drilled in the talar neck and sutured to itself. The anterior talofibular ligament is restored in an anatomical position. (1) Inferior extensor retinaculum. (2) Periosteal flap graft. (3) Transosseous tunnel drilled in talar neck.

Table 1
Good-Jones-Livingstone Grading System of lateral ligament instability

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Full activity, including strenuous sports. No pain, swelling or giving way.</td>
</tr>
<tr>
<td>2</td>
<td>Occasional aching, only after strenuous exercise. No giving way or feeling of apprehension.</td>
</tr>
<tr>
<td>3</td>
<td>No giving way but some remaining apprehension, especially on rough ground.</td>
</tr>
<tr>
<td>4</td>
<td>Recurrent instability and giving way in normal activities, with episodes of pain and swelling.</td>
</tr>
</tbody>
</table>

passed through the talar tunnel and sutured to itself with the foot in neutral position (Figure 3).

For both procedures, postoperative immobilization is achieved through a leg brace for 5 weeks; weight bearing on crutches is authorized for at least 3 weeks. Then a rehabilitation programme is initiated which incorporates not only the usual elements of physical therapy, such as strength and flexibility, but also activities to enhance proprioception and neuromuscular control.

Methods

Results have been evaluated both clinically and radiographically. In order to standardize the results for comparative studies, the functional grading system established by Good et al. [30] (Table 1) and previously used by Sefton et al. [31] has been used.

Table 2
Functional results

<table>
<thead>
<tr>
<th></th>
<th>PBT group*</th>
<th>PFG group†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Grade 2</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Grade 3</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Grade 4</td>
<td>3</td>
<td>2§</td>
</tr>
</tbody>
</table>

* Mean follow-up: 5.5 years.
† Mean follow-up: 3 years.
§ One failure after a secondary traumatic rupture in a soccer player who had fully resumed sports.

Stiffness was also recorded: an impairment of 10° or more in the range of motion (ROM) was considered to be significant.

Resumption of sport was also evaluated by the number of patients returning to a competitive level of practice.

Comparative and postoperative radiological findings were based on standard or intensified images and stress radiographs (talar tilt and anterior drawer tests) were performed manually. Statistical correlation of functional and radiographic results was carried out by the Fischer test.

Results

Follow-up ranged from 1 to 15 years with a mean of 5.5 years for PBT, and from 1 to 4 years with a mean of 3 years for PFG.

Clinical results

The overall results in the PBT group were excellent in seven ankles (grade 1), good in six (grade 2), fair in eight (grade 3) and poor in three (grade 4). In the PFG group, the result ratings were excellent in 10 ankles, good in 10 and poor in two (Table 2).

Seventeen patients who underwent PBT showed significant (≥10°) loss in ROM as compared to only two patients treated by PFG. However, in this series ROM is not statistically correlated with clinical results.

Sports resumption evaluation showed that 45.5% of the patients who underwent PFG resumed their
 sporting activities at the same level (Figure 4) while only 29% of the patients who had PBT were able to resume their activities (Figure 5). Two patients (9%) from the PFG group could not resume sports due to persistant ankle pain or instability versus 11 patients (45.8%) in the PBT group.

The PBT series results were complicated by three ruptures of the transplant, four cases of severe loss of articular mobility, two neuroma of the sural nerve and one algodystrophic syndrome. The PFG series results were complicated by two ruptures of the transplant. In the first case of failure, the periosteal graft was said to be 'weak' on the surgical report; the second one was a secondary traumatic rupture in a soccer player who had fully resumed sports.

Radiological results

Long-term stress radiographs showed better results for the PFG ligamentoplasty series with no case of increased talar tilt (>10°) or increased anterior drawer test (>8mm) versus five patients (21%) and 15 patients (62.5%) in the PBT series, respectively.

A good functional result is statistically correlated (Fischer’s test), with a talar tilt <5° (P<0.01) and an anterior drawer test <8mm (P<0.02) (Table 3).

<table>
<thead>
<tr>
<th>Laximetry</th>
<th>PBT group</th>
<th>PFG group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preop</td>
<td>Postop</td>
<td>Preop</td>
</tr>
<tr>
<td>Talar tilt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;5°</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>5°-10°</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>10°-15°</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>&gt;15°</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Not done</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Anterior drawer test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;8mm</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>8-15mm</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>&gt;15mm</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Not done</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
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One case with osteoarthritic change was reported in the PBT group.

Discussion

The most widely performed procedures in the past have been non-anatomic reconstructions with tenodesis using the peroneus brevis [16–18, 32–35]. Many studies have shown good short-term results, but the long-term results have deteriorated with time, especially in young athletes.

Anatomical reconstructions, with or without augmentation, have been chosen by many authors during recent years because of the biomechanical and clinical drawbacks with non-anatomic techniques [2, 28, 36–39].

In the present study, the overall outcome of the comparison between the two procedures tends to favour PFG. As stated by several authors [8, 23, 39], better functional results are correlated with anatomical reconstructive procedures. The ROM was more often felt to be disturbed after peroneal tenodesis. These observations are confirmed by formerly published data [40–43]. Visser et al. [44] have reported that limitation of the ROM after tenodesis was not infrequent. Brunner and Gaechter [45], Roy Camille et al. [27], Visser et al. [44], Draenert and Müller [46] and Karlsson et al. [47] stress that anatomically accurate techniques of ligamentous reconstruction are more closely linked with preserved ROM and good stability of the ankle joint. Biomechanically, these two types of reconstruction are very different. PBT uses graft material (peroneus brevis tendon) secured in a non-anatomical position, thereby eradicating an active stabilizer of the ankle and locking the sub-talar joint. PFG is an anatomical reconstruction which preserves the lateral active stabilizers of the ankle. The success of this type of reconstruction relies on the quality of the periosteal graft, which varies according to age, sex and morphotype [26]. On the basis of an isometric positioning of ligaments insertion, as usually accepted in knee surgery, we have begun a preliminary study evaluating an original graft procedure using the peroneus tertius tendon. Initial results showed equivalent anatomical and biomechanical advantages but require further clinical evaluation [22].

Conclusion

On the basis of these results, anatomical reconstruction can be recommended: it is easy to perform, has a low rate of complication and gives satisfactory mechanical stability. In our series, PFG has produced a 91% success rate over a 3 years follow-up, and PBT has a 54% success rate. In young athletes, better functional results can be expected with anatomical reconstruction at follow-up.

References


