THE DIAGNOSIS AND TREATMENT OF INSTABILITY OF THE SUBTALAR JOINT

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We have developed a method of measuring anterior displacement of the calcaneus on the talus in instability of the subtalar joint and have used the technique to demonstrate anterior instability in 50 patients (72 feet) showing a positive drawer sign. The angle of the posterior facet of the talus was also measured to assess the bony configuration.

Our patients with subtalar joint instability could be divided into three categories. The first group had a history of trauma leading to ankle instability (26 cases), the second showed generalised joint laxity (10 cases) and the third were young females with a history of chronic stress on the foot and a poor bony block (14 cases).

Satisfactory results were obtained by treating the instability with a brace or by reconstruction of the intersesous talocalcaneal ligament.

Received 23 March 1994; Accepted after revision 6 September 1994

The subtalar joint has an undulating bony configuration stabilised by a number of ligaments. The talus and calcaneus are held close together by the cervical ligament and the intersesous talocalcaneal ligament (Cahill 1965). The latter is located at the centre of rotation (Viladot et al 1984). The joint is stabilised medially by part of the deltoid ligament and laterally by the calcaneofibular and the lateral talocalcaneal ligaments (Sarrafian 1993). It moves around the axis of Henke (Hicks 1953) which passes from the medial side of the neck of the talus through to the posterolateral wall of the calcaneus (Sarrafian 1993), but the range of motion is small.

Leonard (1949) first observed that movement at the subtalar joint increased when the calcaneofibular ligament was sectioned. Subtalar joint instability may occur as a result of a severe lateral ankle sprain. When inversion stress is applied continuously to the foot of a cadaver, rupture of the intersesous talocalcaneal ligament occurs only after that of the anterior talofibular ligament and then the calcaneofibular ligament (Taillard et al 1981). Total rupture of the intersesous talocalcaneal ligament and the cervical ligament results in dislocation of the subtalar joint (Rubin and Witten 1962; Heilman et al 1990). Traumatic dislocation of the subtalar joint is rare (Freund 1989), and in almost all cases of severe ankle sprain (Rubin and Witten 1962) the injury to the intersesous talocalcaneal ligament is a partial rupture or elongation. No calcaneal tilt is evident unless the extent of the injury exceeds elongation and causes rupture (Rubin and Witten 1962; Zwipp and Krettek 1986; Kjaersgaard-Andersen et al 1988; Harper 1992). Elongation of the intersesous talocalcaneal ligament slackens the bony configuration; this results in separation of the subtalar joint and allows anterior displacement of the calcaneus (Fig. 1). Such patients have the symptoms of subtalar joint instability.

Different methods have been proposed for measuring instability of the subtalar joint (Rubin and Witten 1962; Laurin, Ouélet and St-Jacques 1968; Brantigan, Pedegana and Lippert 1977; Clanton 1989; Stephens and Sarmarco 1992). We have developed a method using a dorsoplantar radiograph. It is simple and demonstrates accurately any instability of the subtalar joint. We have assessed our cases and present the clinical findings and a discussion of the management.

PATIENTS AND METHODS

Measurement of subtalar instability. The leg is immobilised with the knee bent and the foot plantigrade. Traction is applied to the heel by a foot plate which holds the foot and keeps the sole in contact with the plate. An X-ray tube is directed 15° away from the vertical and centred on the talonavicular joint. The weight applied to the foot plate is 15 kg for male and 13 kg for female subjects (Fig. 2). A dorsoplantar view is taken at rest followed by a second radiograph with the foot on traction.

The anterior displacement of the subtalar joint is then measured. The perpendicular distance between two cross points on the axis of the foot from the heads of the talus and the calcaneus is measured on the radiograph of the foot at rest and on that of the foot on traction. The difference
Fig. 2
Stress radiography for anterior displacement of the subtalar joint.

Fig. 1
Radiographs showing anterior displacement of the calcaneus at the subtalar joint.

between them equals the displacement of the calcaneus against the talus (Fig. 3).

To evaluate whether the bony configuration of the subtalar joint restricts anterior displacement of the calcaneus against the talus, we measured the angle of the posterior facet of the talus on lateral standing radiographs. An X-ray tube is directed horizontally perpendicular to the axis of the foot and centred 1.0 cm below the tip of the lateral malleolus. The line between the anterior and posterior margins of the superior articular surface of the talus, that is, both ends of the curvature of the trochlea, forms an angle with the tangential line of the posterior facet (Fig. 4).

The symptoms of instability of the subtalar joint include pain in the posterior part of the foot on walking or exercising, associated with a feeling of instability of the ankle. Tenderness is found in the sinus tarsi or in the joint space of the posterior facet. Swelling may be observed in the posterior facet joint. The anterior-drawer sign is positive but is not as obvious as in ankle instability. A click occurs in the anterior-drawer manoeuvre in nearly half of the patients with subtalar joint instability. Stress radiographs show dis-
placement of the calcaneus against the talus of 4 mm or more.

We diagnosed 50 patients (72 feet) seen in our clinic between April 1988 and August 1993 as showing instability of the subtalar joint. There were 11 males and 39 females with a mean age of 28.9 years (8 to 70). We measured subtalar joint instability and compared the measurements with those of ten patients each of whom had instability only in the ankle of one foot and of a control group of six subjects (12 feet) with no foot-related complaints.

We routinely take a stress radiograph for patients showing a positive drawer sign. In a previous study (Kato et al 1988), we found subtalar instability in 24 (16.6%) out of 145 such cases.

We divided our patients with subtalar joint instability into three groups. The first (26 cases) had an obvious history of trauma, the second (10 cases) had generalised joint laxity, and the third (14 cases) was a group of young females with a history of chronic stress to the foot. The frequency was highest in the trauma group. Females are generally predisposed to this disorder. In the trauma group 22 of the 26 patients had sustained major injury such as avulsion fracture of the tip of the lateral malleolus. Generalised joint laxity was assessed using Carter’s criteria (Carter and Wilkinson 1964). In the third group, 12 of the 14 patients played strenuous sports using their feet (Tables I and II).

**Table I. Details of 50 patients with subtalar instability**

<table>
<thead>
<tr>
<th>Group</th>
<th>Trauma</th>
<th>Joint laxity</th>
<th>Young female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>26</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>Male:female</td>
<td>9:17</td>
<td>2:18</td>
<td>0:14</td>
</tr>
<tr>
<td>Mean age (yr)</td>
<td>31.9</td>
<td>45.3 (female only)</td>
<td>18.6</td>
</tr>
<tr>
<td>Right:left</td>
<td>18.5</td>
<td>3:0</td>
<td>0:2</td>
</tr>
<tr>
<td>Bilateral</td>
<td>3</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>History of injury</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>22</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Slight</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Generalised joint laxity</td>
<td>2</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Strenuous sport using feet</td>
<td>6</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>Avulsion fracture</td>
<td>11</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Osteoarthritic change</td>
<td>9</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
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**Methods of treatment.** Symptoms are eliminated in most cases of subtalar joint instability when the patient avoids standing or walking for long periods of time or stops participating in sports. A brace may be used to decrease the pain. It does not inhibit ankle movement, but protects the

**Table II. Measurement of the degree of instability, talar tilt and facet angle (mean ± sd) in the groups with subtalar instability and ankle instability and the control group (see text)**

<table>
<thead>
<tr>
<th></th>
<th>Displacement of the subtalar joint (mm)</th>
<th>Displacement of the ankle (mm)</th>
<th>Talar tilt (degrees)</th>
<th>Facet angle (degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trauma group (29 feet)</td>
<td>5.3 ± 0.7</td>
<td>7.8 ± 2.4</td>
<td>11.4 ± 7.3</td>
<td>35.9 ± 5.6</td>
</tr>
<tr>
<td>Joint laxity group (17 feet)</td>
<td>5.0 ± 1.0</td>
<td>7.5 ± 2.0</td>
<td>12.9 ± 3.5</td>
<td>35.0 ± 3.8</td>
</tr>
<tr>
<td>Young female group (26 feet)</td>
<td>5.0 ± 0.7</td>
<td>6.4 ± 1.7</td>
<td>8.0 ± 2.2</td>
<td>29.7 ± 1.6</td>
</tr>
<tr>
<td>Ankle instability group (10 feet)</td>
<td>2.0 ± 1.3</td>
<td>8.9 ± 1.7</td>
<td>14.8 ± 8.7</td>
<td>39.1 ± 4.0</td>
</tr>
<tr>
<td>Control group (6 feet)</td>
<td></td>
<td></td>
<td></td>
<td>38.2 ± 6.2</td>
</tr>
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</table>
talar tilt and anterior drawer of the subtalar joint (Fig. 5). Surgical treatment is indicated for patients with severe symptoms who are not willing to wear a brace. We used ligamentous reconstruction.

A tunnel 4.5 mm in diameter is made in the talus and the calcaneus from just in front of the talar trochlea medially to the laterolateral corner and beneath the sulcus of the calcaneus. A portion of tendon Achilles, 4 mm wide and 5 cm long, taken from the lateral margin, is inserted into a tubed Leeds-Keio artificial ligament 5 mm in diameter. This is passed through the bony tunnel, and both ends are fixed with two staples on the bony surfaces (Fig. 6). A below-knee plaster is applied with the foot in the neutral position for six weeks after surgery. Exercise, mainly peroneal muscle strengthening, is then encouraged with the use of a leather brace for three months for support during running or sports.

We have so far operated on 14 feet in 14 patients; six in the trauma group, six in the young female group, and two in the joint laxity group. Reconstruction of the talocalcaneal interosseous ligament alone was undertaken in two patients, and combined with triligamentous reconstruction for ankle instability (Fig. 6: Kato 1987) in a further 12. Five of these patients with the os trigonum syndrome also had resection of the posterior process of the talus.

We assessed the short-term results of the operation in 12 patients (12 feet) who were followed up for three to seven years (average 4.5 years). We compared these with the results of the operations on six patients who received triligamentous reconstruction alone for ankle instability, but were later found also to have subtalar joint instability. The results of the operation were assessed according to the criteria of the Japanese Foot Society.

RESULTS

Degree of instability. The average anterior displacement of the calcaneus against the talus was over 5 mm in each of the three groups with subtalar instability, while 2 mm was the average displacement in the group with ankle instability alone.

The degree of anterior displacement of the talus against the ankle mortice was large in the group with ankle instability, and slightly smaller in the young female group. In the latter group the degree of talar tilt was significantly smaller (Table II).

Facet angle. The facet angles of the normal control group were scattered and averaged 38.2°. Those of the ankle instability group were almost the same as in the normal control group. The young female group had smaller facet angles than the other two groups with subtalar joint instability (Table II).
Operative treatment. All 14 patients operated on for subtalar instability had excellent results (55 points) with significant improvement in pain and instability. Thirteen of the patients were satisfied with their result. Two of the six patients who had reconstruction of the lateral collateral ligament of the ankle alone had slight pain and a feeling of instability, with an average score of 52 points (Table III). Comparing the results of stress radiography after the two procedures, displacement of the calcaneus against the talus after operation for subtalar instability changed from 4.9 mm to 2.3 mm. In the group which had ligamentous reconstruction of the ankle alone, the preoperative displacement was the same as that in the group with subtalar instability at 4.8 mm; this changed to 3.8 mm after operation with a little improvement in instability (Table IV).

DISCUSSION
Lesions of the ligamentous structures in the sinus and canalis tarsi have been shown to have common links with sinus tarsi syndrome (Zwipp and Tscherner 1982; Kjaersgaard-Andersen et al 1988). There is confusion between subtalar joint instability and the sinus tarsi syndrome because there is as yet no agreed method of radiological measurement of subtalar motion. Our method of measuring subtalar joint instability is exact and reproducible and enables both types of disorder to be differentiated.

In a previous study, subtalar instability was found in

| Table III. Results of operation according to the criteria of the Japanese Foot Society |
|---------------------------------|-----------------|-----------------|
|                                  | Reconstruction of the talocalcaneal interosseous ligament | Triligamentous reconstruction |
| Trauma                          | 7.5 to 20       | 7.5 to 18.3     |
| Instability                     | 5.3 to 10       | 5.3 to 8.7      |
| Gait ability                    | 7.0 to 10       | 6.7 to 10       |
| Muscle power (peroneals)        | 3.3 to 5        | 3.0 to 5        |
| Activities of daily living      | 8.9 to 10       | 8.7 to 10       |
|                                 | 32 to 55 (total possible) | 31.2 to 52     |
| Patient satisfaction            | 11/12           | 4/6             |

Fig. 6
Ligamentous reconstruction of the ankle and subtalar joint.
16.6% of all patients who showed a positive anterior drawer sign at the ankle (Kato et al. 1988). Between 10% and 25% of patients with lateral instability of the ankle have a subtalar instability (Brantigan et al. 1977; Larsen 1988), and the subtalar joint must be assessed in the presence of chronic instability of the lateral ankle ligament.

Many of our patients with subtalar joint instability had no history of injury. Laxity of the interosseous talocalcaneal ligament may occur as one symptom of generalised joint laxity. A congenitally flat bony configuration of the posterior facet of the subtalar joint is another factor which may lead to anterior displacement of the calcaneus. In the presence of such predisposing causes subtalar joint instability occurs when the foot is subjected to a sufficient degree of stress. In our group with generalised joint laxity such stress can be due to several decades of ordinary activity with the symptoms appearing in middle age; in the young female group it is the result of playing strenuous sports involving the feet over some period of time. In patients with generalised joint laxity, the mean facet angle is smaller in subtalar instability than in ankle instability. This difference was statistically significant. In the trauma group, the facet angles are varied in size in patients who had a major injury with an avulsion fracture of the lateral malleolus. Where the injury was less severe, without this fracture, the mean size of the facet angle is reduced, being less than 35° (Fig. 7) (Ando et al. 1989).

It has been suggested that the Evans and Watson-Jones operations are ineffective for this disorder (Gillespie and Boucher 1971; Nicholas 1974; Brantigan et al. 1977), but others have reported success using a modified Elmslie method (Chrisman and Snook 1969; Vidal et al. 1974; Zell et al. 1986; Zwipp and Krettek 1986). Horstman, Kantor and Samuelson (1981) reported that after the modified Elmslie procedure subjectively unstable ankles were still recognised in 18% of patients who had an average talar tilt of less than 5°, which lay within normal limits. They suggested evaluation of the subtalar joint as a possible source of the instability.
Our modified Chrisman-Snook method reconstructs the anterior talofibular ligament, the calcaneofibular ligament, and the lateral talocalcaneal ligament, creating a bony insertion that is close to the normal location. We have shown, however, that not all patients can be treated successfully by this method alone. Schon, Clanton and Baxter (1991) reconstructed the calcaneofibular, anterior talofibular and cervical ligaments for ankle and subtalar instability using the plantaris tendon or the peroneus brevis tendon but did not describe the operated cases and gave no objective evaluation of stability. A key point in the correction of subtalar instability is not to prevent calcaneal tilt, but to hold the talus and the calcaneus close to each other. The interosseous talocalcaneal ligament should therefore be reconstructed to prevent the separation of the two bones and to restrict the anterior displacement of the calcaneus. This procedure does not inhibit subtalar motion because the reconstructed ligament is located near the axis of rotation. Using an artificial ligament as a reinforcement can shorten the initial period of immobilisation and provide support for the graft. Only one patient experienced a complication, which was slight pain on the medial side of the talar neck. The pain disappeared on removal of the staples. We have encountered no cases requiring subtalar fusion or triple arthrodesis.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

REFERENCES


Cahill DR. The anatomy and function of the contents of the human tarsal sinus and canal. Anit Rec 1965;153:1-17.


