Outcome after fixation of ankle fractures with an injury to the syndesmosis

THE EFFECT OF THE SYNDENOSIS SCREW

The purpose of this study was to compare the clinical and radiological outcome of patients with intact, broken and removed syndesmotic screws after Weber B or C ankle fracture with an associated injury to the syndesmosis. We hypothesised that there would be no difference. Of a possible 142 patients who fulfilled our inclusion criteria, 52 returned for clinical and radiological assessment at least one year after surgery. Of these, 27 had intact syndesmosis screws, ten had broken screws, and 15 had undergone elective removal of the screw. The mean American Orthopaedic Foot and Ankle Society ankle/hindfoot score was 83.07 (SD 13.59) in the intact screw group, 92.40 (SD 12.69) in the broken screw group, and 85.80 (SD 11.33) in the removed screw group (p = 0.0466).

There was no difference in clinical outcome of patients with intact or removed syndesmotic screws. Paradoxically, patients with a broken syndesmosis screw had the best clinical outcome. Our data do not support the removal of intact or broken syndesmosis screws, and we caution against attributing post-operative ankle pain to breakage of the syndesmosis screw.

Fractures of the ankle are common. Some have an associated injury to the syndesmosis, which disrupts the distal tibiofibular joint. This has to be addressed when the primary fracture is fixed to avoid a poor outcome.1 It is widely accepted that reduction of the syndesmosis and placement of one or more screws across the distal tibia and fibula restore the anatomy and allow the syndesmosis to heal.2-4 There is, however, no consensus about the specifics of screw placement with regard to screw size, the number of cortices that need to be fixed, the position of the foot when the screws are inserted, the number of screws needed, and whether the screws should be removed once the syndesmosis has healed.5-10

The syndesmosis is thought to heal in eight to 12 weeks,11 at which point the decision has to be made whether to remove the screw or not.9 The potential advantages of removing the screw include a theoretical improvement in ankle movement3,12 and the prevention of potential screw breakage. The disadvantages include the need for a second surgical procedure and the possibility of losing the reduction once the screw has been removed. Because it has been suggested that leaving metal screws in place results in a poorer outcome, other devices such as bioabsorbable screws and tightrope systems, have been developed and are gaining in popularity.9,13

The purpose of this study was to compare the clinical and radiological outcome of patients with intact, broken and removed syndesmosis screws. We anticipated no difference between the three groups.

Patients and Methods

Institutional review board approval was obtained before enrolling patients in the study. Inclusion was limited to patients who had undergone open reduction and internal fixation of an ankle fracture with screw stabilisation of a disrupted syndesmosis; injury to the syndesmosis was confirmed at operation.14 The time from surgery was at least one year. The exclusion criteria were age < 18 years, syndesmosis screw placed for reasons other than disruption of the syndesmosis, chronic injury (> one month) of the syndesmosis, post-operative infection, post-operative hardware failure prior to bone healing, post-operative complications requiring additional surgery, and placement of a bioabsorbable syndesmosis screw. Patients were identified between 2001 and 2005 from their Current Procedural Terminology (CPT) codes for open treatment of medial and/or lateral malleolus fracture, and open treatment of distal tibiofibular (syndesmosis) disruption. All clinical notes and radiographs were reviewed before the patients...
were enrolled to confirm the CPT data. The patient’s age and gender, fracture pattern (Danis-Weber), insurance status and mechanism of injury were obtained from the clinical records (Table I).

Post-operatively, each patient had been immobilised in a cast or boot and weight-bearing was restricted for at least eight weeks. Once fracture healing was apparent radiologically, the patient resumed bearing weight on the affected ankle. The syndesmosis screw was removed at 12 weeks if the treating surgeon so wished.

Each patient was given $50 for taking part in the study. The syndesmosis screws were removed or not depending on the preference of the individual surgeon. Of the five surgeons involved in the study two preferred to remove the screw at 12 weeks and three did not remove them at all.

Clinical assessment. A total of 142 patients met the enrolment criteria, 52 (37%) of whom agreed to take part in the study and returned for clinical and radiological assessment. There were 28 men (54%) and 24 women (46%) with a mean age of 47 years (21 to 72). There were 15 Weber B fractures (29%) and 37 Weber C fractures (71%).

Patients who consented to participate in the study completed the American Orthopaedic Foot and Ankle Society (AOFAS) ankle/hindfoot score and a visual analogue scale (VAS) for ankle pain. They were also assessed for tenderness at the site of the syndesmosis screw. Each patient was examined and the clinical outcome data were recorded by the authors, who were blinded to the radiographs at the time of clinical assessment. The AOFAS ankle/hindfoot score was chosen as the primary outcome measure. It includes three subscores for pain, function and alignment and has been found to be both valid and reliable.16

Radiological assessment. Each patient had anteroposterior (AP), lateral and mortise views of the ankle taken at follow-up. We recorded the tibiofibular clear space, that is, the horizontal distance between the lateral margin of the posterior tibial malleolus and the medial border of the fibula; any radiolucency around the syndesmosis screw and whether or not the screw had broken. Radiographs were only interpreted after all the patients had been enrolled.

Statistical analysis. All data were entered into a secure database (Microsoft Excel, Microsoft, Redmond, Washington). Descriptive statistics, including means, SD, and percentages, were calculated. For nominal data, the chi-squared test or Fisher’s exact test were used. Non-parametric statistics were used for the other variables, as they were either ordinal or not normally distributed. The Kruskal-Wallis test compared the distributions of the three groups (retained and intact syndesmosis screw, retained and broken screw, and removed screw). SAS software version 9.1 (SAS Inc., Chicago, Illinois) was used for all analyses. A two-tailed p-value of < 0.05 was considered statistically significant.

Results
The mean follow-up was 30 months (12 to 56) from operation. The study population was separated into three

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**Table I.** Patient demographics and fracture pattern

<table>
<thead>
<tr>
<th>Screw</th>
<th>Intact</th>
<th>Broken</th>
<th>Removed</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>27</td>
<td>10</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Mean age (range)</td>
<td>50 (22 to 72)</td>
<td>35 (21 to 63)</td>
<td>50 (21 to 69)</td>
<td>0.081</td>
</tr>
<tr>
<td>Male (%)</td>
<td>44</td>
<td>80</td>
<td>53</td>
<td>0.174</td>
</tr>
<tr>
<td>Fracture pattern (Weber class)</td>
<td>9B, 18C</td>
<td>3B, 7C</td>
<td>3B, 12C</td>
<td>0.716</td>
</tr>
<tr>
<td>Mean time to full weight-bearing (weeks)</td>
<td>10.2 (8 to 26)</td>
<td>10.5 (8 to 18)</td>
<td>9.7 (8 to 13)</td>
<td>0.217</td>
</tr>
<tr>
<td>Insurance status</td>
<td></td>
<td></td>
<td></td>
<td>0.097</td>
</tr>
<tr>
<td>Private</td>
<td>15</td>
<td>8</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>2</td>
<td>4</td>
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</tr>
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</table>

**Table II.** Clinical outcome based on the integrity of the syndesmosis screw

<table>
<thead>
<tr>
<th>Screw retained</th>
<th>Intact</th>
<th>Broken</th>
<th>Screw removed</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>27</td>
<td>10</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Visual analogue scale</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>2.31 (2.76)</td>
<td>0.96 (2.31)</td>
<td>0.74 (0.97)</td>
<td>0.217</td>
</tr>
<tr>
<td>AOFAS*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>83.07 (13.59)</td>
<td>92.40 (12.69)</td>
<td>85.80 (11.33)</td>
<td>0.0466</td>
</tr>
</tbody>
</table>

* AOFAS, American Orthopaedic Foot and Ankle Society
groups based on the state of the syndesmosis screw at follow-up: group I (intact, n = 27), group B (broken, n = 10), and group R (removed, n = 15). There was no statistical difference between the demographics of the three groups (Table I).

The 15 screws that had been removed were removed after a mean of 13.1 weeks (11 to 20). Of these, eight patients began full weight-bearing before the screw was removed at a mean of 9.7 weeks (8 to 13). There were no associated complications. No patient needed their screw removed for pain or broken hardware.

Radiological outcome. All the screws were fully threaded 3.5 mm stainless steel screws. Of these, 45 had penetrated three cortices. The seven that engaged four cortices were evenly dispersed among the three groups (group I, 3; group B, 2; group R, 2). The number of cortices engaged did not correlate with screw breakage or clinical outcome.

Of the 52 patients, 41 had a single syndesmosis screw and 38 of these engaged three cortices. The other 11 patients had two syndesmosis screws implanted (group I, 3; group B, 3; group R, 5). The number of screws was determined by the operating surgeon, influenced by the degree of injury to the syndesmosis detected intra-operatively.

A radiolucency around the syndesmosis screw were seen in 25 of 37 patients (68%) in whom the screw had been retained. This was not associated with any loss of reduction.

Radiographs showing three patients a) with similar Weber B ankle fractures; b) all three underwent open reduction and internal fixation including a syndesmosis screw; c) at final follow-up, patient 1 had an intact syndesmosis screw, patient 2 a broken syndesmosis screw and patient 3 had the syndesmosis screw electively removed prior to full activity. The American Orthopaedic Foot and Ankle Society ankle/hindfoot scores were similar in the three patients: patient 1, 85; patient 2, 81; patient 3, 80.
as judged by the tibiofibular clear space. The mean among all 52 patients was 4.1 mm (3.2 to 5.5), and no patient had a tibiofibular clear space that measured more than 6 mm. There was no correlation between radiolucency around the syndesmosis screw and AOFAS or VAS scores (AOFAS p = 0.639, VAS p = 0.537).

**Clinical outcome.** The mean AOFAS ankle/hindfoot score for the whole group was 85.2 (55 to 100) and the mean VAS 1.6 (0 to 84).

There were two (5%) of the 37 patients with retained screws who had local tenderness.

Table II shows the clinical outcome. The mean VAS for ankle pain was 2.31 (SD 2.76) in group I, 0.96 (SD 2.31) in group B, and 0.74 (SD 0.97) in group R (p = 0.217). The mean AOFAS ankle/hindfoot score was 83.07 (SD 13.59) in group I, 92.40 (SD 12.69) in group B, and 85.80 (SD 11.33) in group R (p = 0.0466). The mean AOFAS subscores of pain were 29.25 (0 to 40) in group I, 36.0 (20 to 40) in group B and 30.0 (20 to 40) in group R. The mean AOFAS subscores for function were 45.67 (31 to 50) in group I, 46.4 (31 to 50) in group B, and 45.8 (30 to 50) in group R.

The patients were also divided into screw removed and screw retained (broken and intact) groups. Very similar clinical results were found when the two groups were compared; a mean VAS of 2.02 (SD 2.70) in the ‘screw retained’ group (p = 0.268) and 0.074 (SD 0.97) in the ‘screw removed’ group. The mean AOFAS score was 85.59 (SD 13.83) in the screw retained group and 85.80 (SD 11.33) in the screw removed group (p = 0.714).

**Discussion**

In this retrospective study of 52 unmatched patients who underwent screw fixation of the syndesmosis for a Weber B or C fracture of the ankle, there was no statistical difference between the clinical outcomes of patients who had the screw removed and those who retained an intact screw. Patients who retained a broken screw were found to have the best clinical outcome. Figure 1 shows the pre- and postoperative radiographs of three patients with a Weber B fracture who were included in this study. Although the fate of the syndesmosis screw was different in each case, the AOFAS ankle/hindfoot scores were very similar (patient 1, 85; 2, 91; 3, 90).

Historically, it was thought that a screw placed across the syndesmosis impaired proper movement of the ankle and the distal tibiofibular joint. In 1989, Needleman et al. published a biomechanical analysis of ankle movement before and after placement of a single 4.5 mm syndesmosis screw in cadavers. They found significant limitation of tibiotalar external rotation and anterior/posterior translation with the foot in plantar flexion. They found no difference in dorsiflexion or plantar flexion of the ankle. On this basis, they recommended removal of the syndesmosis screw before the patient returned to full activity. Our clinical results are at odds with theirs. In our series, the function subscore of the AOFAS ankle/hindfoot outcome assessment showed similar movement among the three groups (intact, 45.67; broken, 46.4; removed, 45.8). This difference may be accounted for by the high incidence of radiolucency (68%) around the syndesmosis screw, which implies movement between the distal tibia and the fibula. There was no correlation between radiolucency and clinical outcome, suggesting that micromovement at the screw-bone interface is not a significant source of pain, and that removal of the screw is unnecessary. Beumer et al. performed radiostereometry during ankle movement and found that micromovement occurs at the distal tibiofibular joint. They concluded that the fibula rotates externally and translates medially and posteriorly when an external rotation force is applied to the foot. In our series, 41 of the 52 patients had only one syndesmosis screw, and most of these were tricortical. We were unable to detect a difference in clinical outcome or fate of the syndesmosis screw in relation to the number of cortices engaged. Usually we implant one 3.5 mm cortical screw which engages three cortices, unless additional fixation is needed to provide adequate stability to external rotation stress. Perhaps this allows enough movement for normal function despite the presence of the screw. Our results are similar to those of Heim, Heim and Regazzoni, who found that 91% of patients with a retained tricortical screw had evidence of micromovement. They concluded that a small amount of movement prevents screw breakage. Figure 2 shows a patient with significant radiolucency around the syndesmosis screw.
radiolucency around the syndesmosis screw. This patient had an excellent outcome (AOFAS, 100; VAS, 0) despite micromovement and retention of the syndesmosis screw.

There are few published data comparing the clinical outcome after removing the syndesmosis screw or not. In 2006, Bell and Wong,6 retrospectively reviewed 30 patients. The screw was removed in 23 and retained in seven, of which two subsequently fractured. The authors found no difference in ankle pain, range of movement or functional outcome between the two groups but still cautioned against leaving the screw in place because of the high breakage rate on weight-bearing. Our data do not support the view that screw breakage is associated with an inferior clinical outcome.

We recognise some limitations of this study. This was a retrospective review of a non-randomised sample drawn from one hospital. The decision to remove the syndesmosis screw was taken by the operating surgeon, which led to unmatched groups of patients. Nonetheless, there was no statistically significant difference in the demographics between the three groups of patients.

Only 52 of the possible 142 patients were evaluated. This was due largely to the difficulty of following and contacting this relatively young mobile population of trauma patients.

Paradoxically, we found that patients with broken syndesmosis screws had the best clinical outcomes. It should be noted that there was a tendency for these patients to be younger than those in the other two groups (p = 0.081). Perhaps these younger patients were more active during their rehabilitation, leading to a fatigue fracture of the syndesmosis screw. Nevertheless, no loss of reduction was seen in this group and failure of the screw did not result in a poor clinical outcome. Furthermore, we would caution against attributing post-operative ankle pain to breakage of the syndesmosis screw, as this group had the least ankle pain in our series.

In conclusion, we found no statistical difference in clinical outcome of patients who had their syndesmosis screw removed and those who did not. However, patients with broken screws fared best of all (p = 0.466). Widening of the syndesmosis was not seen after removal or breakage of the screw. Our data do not support the routine removal of the intact or broken syndesmosis screw.

Supplementary material
A further two tables showing details of clinical outcome based on removal versus retention of the syndesmosis screw, and presence or absence of radiolucency around the syndesmosis screw are available with the electronic version of this article on our website at www.jbjs.org.uk

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References