Two-Screw Fixation Construct for Subtalar Joint Fusion: Revisited – A Retrospective Review

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Primary fixation at the subtalar joint sub-fusion site is provided by the posterior screw (blue arrow). (a) The fully threaded anterior screw (yellow arrow) does not enter the navicular bone but provides stability to protect against rotational forces that could compromise healing. (b) If the middle and anterior subtalar joint facets are preserved, then the posterior screw (green arrow) can be used to provide compression in addition to stability.

Figure 2. Excluded STJ fixation constructs

Primary compression at the subtalar joint sub-fusion site is provided by the posterior screw (blue arrow). (a) The fully threaded anterior screw (yellow arrow) does not enter the navicular bone but provides stability to protect against rotational forces that could compromise healing. (b) If the middle and anterior subtalar joint facets are preserved, then the posterior screw (green arrow) can be used to provide compression in addition to stability.

Figure 1. Divergent screw fixation construct for subtalar joint fusion

STJ fixation has been described for the surgical management of many painful rearfoot conditions, congenital and acquired. Examples include end-stage osteoarthritis of the STJ, post-traumatic arthritis, STJ instability, pathologic pronation, posterior tibial tendon dysfunction (PTTD), caudus deformity, and tarsal coalition (1). Non-union rates from 0% to 33.8% have been reported, with certain risk factors found to negatively impact fusion rate (2-3). Many reports have focused on fusion rates associated with specific fixation constructs. Examples of constructs described include one, two and three screw fixation with headdless or threaded screws in various arrangements, staples, external fixation, and bone dowels (4-5). In 2012, Boffeli and Reinking described a divergent fixation construct with a retrospective case series involving 15 patients (6). A 100% fusion rate was reported based on review of lateral and axial radiographs at 10 weeks. This construct has been subsequently reported to be biomechanically superior to a single posterior screw across the STJ and two posterior screws across the STJ, in both parallel and divergent orientations (6-7).

Figure 3. Anterior screw incision and guide pin placement

- (a) Incision for anterior screw (green arrow) is placed at the lateral heel, inferior to the planar calcaneal margin 3 cm proximal to and parallel with the calcaneocuboid joint. This incision placement avoids iatrogenic injury to the sural nerve and peroneus longus tendon. Following blunt dissection to bone (b) the anterior guide pin (yellow arrow) is inserted, with fluoroscopy used to confirm desired starting point and trajectory. The pin enters the calcaneus off the weightbearing surface and is directed to the talar neck, parallel to the midtarsal joint. Ideal posterior guide pin position is also shown (blue arrow).

Table 1. Summary of results (n=51 cases in 40 patients)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total</th>
<th>Subtotal</th>
<th>STJ fuse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Mean: 53.8 years (range 20-70)</td>
<td>Male: 13/49 (26.5%), Female: 36/49 (73.4%)</td>
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<tr>
<td>Radiographic union of STJ fusion at 10 weeks</td>
<td>51/51 (100%)</td>
<td></td>
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<tr>
<td>Cases requiring revision</td>
<td>1/51 (2.0%)</td>
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<tr>
<td>Cases requiring hardware removal</td>
<td>4/51 (7.8%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Both (anterior and posterior screw removal)</td>
<td>2/51 (3.9%)</td>
<td></td>
<td></td>
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<tr>
<td>Posterior screw alone</td>
<td>2/51 (3.9%)</td>
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The anterior screw for subtalar joint fusion is not used in cases with concomitant (a) lateral ankle joint or (b) calcaneocuboid joint fusion, due to interference with and anterior stabilization provided by midtarsal joint fixation. Twenty-two cases were excluded for this reason.

RESULTS

Our review identified 74 cases of STJ fusion. Of these cases, 51 (49 patients) involved primary fusion using the divergent 2 screw construct previously described by Boffeli and Reinking (6). The mean age of the patients who met the inclusion criteria was 53.8 years (range 20-70). Of those who were included, 13 patients (26.5%) were male and 36 patients (73.4%) were female. Preoperative indications for fusion included flatfoot deformity, PTTD, tarsal coalition, caudus deformity, and peroneal tendon dysfunction. Osseous union at 10 week follow-up was identified in 51/51 (100%) of cases. Following successful fusion, 1 case (2%) required positional revision at 3.5 months following the procedure due to unipinated STJ alignment with lateral column overload. Hardware removal was required in a total of 4 cases (7.8%).

Table 3. Comparison of constructs for STJ fusion

<table>
<thead>
<tr>
<th>Construct</th>
<th>Performance</th>
<th>Radiographic Union at 10 weeks</th>
<th>Postural Revision</th>
<th>Hardware Removal</th>
<th>Screw Fixation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Screw</td>
<td>Successful fusion in 51/51 (100%) cases</td>
<td>1/51 (2.0%)</td>
<td>4/51 (7.8%)</td>
<td>0/51 (0%)</td>
<td>3/51 (6.0%)</td>
</tr>
</tbody>
</table>

Figure 3. Anterior STJ screw fusion construct

The anterior screw for subtalar joint fusion is not used in cases with concomitant (a) lateral ankle joint or (b) calcaneocuboid joint fusion, due to interference with and anterior stabilization provided by midtarsal joint fixation. Twenty-two cases were excluded for this reason.

Figure 4. Anterior and posterior guide pin orientation

Desired orientation of anterior and posterior guide pins is shown (a) radiographically and (b) clinically. (c) Viewed from posteriorly, angulation between the anterior guide pin (yellow arrow) and the posterior guide pin is shown in red. This angle is typically 45° but may vary with refoot alignment after deflection correction.

Figure 5. Intraoperative fluoroscopy following divergent screw placement

Final fluoroscopic imaging following divergent screw placement demonstrates appropriately placed screws and desired anatomic orientation. AP and lateral imaging confirms reduction of posterior screw in the calcaneus (blue arrow) and the anterior screw in the talar neck (yellow arrow). Medial-oblique imaging is used to assess full seating of the anterior screw. Note: multipleplanar divergence which adds stability to the construct.

ANALYSIS AND DISCUSSION

Each fixation construct for STJ fusion that has been described in the published literature has advantages and disadvantages. DeCarlo et al. found no statistical difference between the fusion rates associated with various fixation techniques for STJ fusion (1). Our review included 74 STJ fusion cases, including 10 different STJ fixation techniques. Two of the techniques involved using a single screw across the STJ and a second screw across the posterior facet. However, an issue with the single screw construct across the STJ is that a fall or premature ambulation during the 10 week postoperative healing phase could result in loss of compression and potentially compromise osseous union. While a second screw across the posterior facet has been shown to increase stability, there is no added osseous union that occurs due to osseous union and can increase the potential for pain with weight bearing. The fixation construct we describe avoids the biomechanics of the posterior facet, directed from the posterior to the anterior facet. The anterior screw fixation for osseous union is maximized as only one screw crosses the posterior facet.

One STJ fusion patient with divergent screw placement identified in our initial review was excluded, as they were referred to author T.J.B. for revision of nonunion after fusion by a different surgeon. This patient was a high-risk patient with history of coronary artery disease who was non-compliant with weight bearing recommendations, and continued to ambulate postoperatively. The patient eventually went on to osseous union across the STJ after a second attempt at revision using our divergent screw fixation and augmentation with bone graft. This case highlights the utility of our divergent construct for high-risk patients who require additional stability due to expected premature weight bearing or need long-term stability at the fusion site in cases of anticipated slow union due to diabetes, continued tobacco use, or poor bone quality.

Twenty-two additional STJ fusion cases identified in our initial review were excluded as they involved concomitant talonavicular (TNA) and subtalar (STT) fusion. The construct described was not used in these cases, as midtarsal joint fixation serves as anterior stabilization. Additionally, the position of the hardware for TNA and STT joint fusions is critical.

We did not identify other complications associated with anterolateral screw placement including sural nerve injury and peroneus longus tendon injury. The location of the incision for this screw is important, as improper placement risks damage to the FAL nerve and peroneus longus tendon. Figure 3 demonstrates markings for incision planning and pearls for placement.

This study is limited by its retrospective design and could be strengthened by a direct comparison of our divergent construct for STJ fusion with other commonly employed fixation constructs allowing more robust statistical analysis. The 100% union rate and low complication rate described is partly related to what we consider an optimal screw fixation but is also influenced by our overall STJ fusion protocol involving cessation of smoking, bone health assessment, comprehensive preoperative preparation, normalization of high ATG, thorough joint preparation, and strict NWB during the initial healing phase. In conclusion, we have found that STJ fusion using the divergent screw construct appeared to be safe and effective based on follow-up by 10 weeks and is associated with a low rate of hardware removal.

REFERENCE