Radiographic and Clinical Evaluation of Syndesmotic Screws in Treating Injuries of the Distal Aspect of the Tibiofibular Syndesmosis

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Abstract

Background: Several factors can affect the success of surgical treatment of injuries to the distal aspect of the tibiofibular syndesmosis, including the bony articulation between the distal aspect of the fibula, tibia, and the supporting ligamentous structures; number and size of screws; number of cortices penetrated; and planned routine removal of screws.

Methods: We conducted a retrospective review of radiographs and clinic notes for all patients who underwent open reduction and internal fixation of injury to the tibiofibular syndesmosis, which was performed by a single surgeon (RAM), between January 2011 and December 2014. Only screws were used. The screws were removed postoperatively if pain was noted or if requested by the patients. Exclusion criteria included patients with fractures treated initially with external fixation and patients with diabetic neuropathy; ultimately, 44 patients were included in the study.

Results: During postoperative follow-up, eight screws broke and six screws loosened. Two broken screws and one loose screw were causing symptoms of pain and subsequently removed. One broken screw was replaced owing to loss of fixation. Four intact screws were causing pain and later removed.

Conclusions: There is not a clearly defined advantage to routine screw removal. Risks and costs associated with an additional operative treatment for routine removal are likely unnecessary, but removal when the hardware results in pain is recommended. Treatment outcomes were similar between cortices crossed, number of screws used, and placement of screws through plates.

Introduction

Multiple methods exist regarding appropriate use of screws with operative treatment of syndesmosis-related injuries of the ankle. Studies have debated the benefits and risks of the size and number of screws, number of cortices through which the screws should penetrate, and whether to routinely remove the screws after treatment.[1,2,3]

Because the fibula has some motion relative to the tibia during ankle motion and gait, surgeons have argued that fixation of three cortices instead of four may result in more frequent loosening of the syndesmotic screws and subsequent restoration of distal tibial-fibular motion.[4] However, several recent papers have described no definitive evidence supporting improved treatment outcomes involving three cortices versus four.[5,6] Similarly, routine postoperative removal (ie, at several months after the treatment) of syndesmotic screws has been proposed to restore distal tibial-fibular motion and improve ankle function.[7] The size of screws is another debate in treating syndesmotic injuries. The use of larger screws (eg, 4.5 mm) has been noted to result in improved fixation and less chance of premature screw breakage, yet the clinical advantage has not yet been proven.[8] Other surgeons have noted that screws often break after postoperative healing, which suggests a possible advantage to less robust, 3.5mm screws.[9] Yet it is unclear whether restoration of syndesmotic motion is important for ankle function.

To better understand the question of optimal screw number, screw size, number of cortices of fixation, and whether to routinely remove syndesmotic screws, we reviewed patients with operatively treated syndesmosis injuries. We focused particularly on postoperative outcomes of the syndesmotic screws. During this period, it was the senior author's practice to not routinely remove syndesmotic screws unless desired by the patient. Removal was also offered for persistent pain or ankle stiffness.

Methods

We received approval from our Human Research Review Committee (HRRC #16-391). We reviewed radiographs and orthopaedic clinic notes of patients who underwent open reduction and internal fixation (ORIF) for treating syndesmosis injuries between January 2011 and December 2014. During this period, the senior author performed ORIF for treating 197 malleolar ankle fractures. Exclusion criteria were fractures treated initially with external fixation and patients with diabetes and symptoms of neuropathy; ultimately, 44 patients (22%) underwent reduction and fixation of the syndesmosis and were included in the study.

We noted the associated fractures operatively repaired and the treatment method. Follow-up radiographs were evaluated for status of the syndesmosis fixation. We also documented whether the screws had been removed, broken, or loosened with loss of alignment. Figure 1 shows the location of broken screws; zones 1, 2, and 3 represent screws that broke within the fibula, syndesmosis, and tibia, respectively.

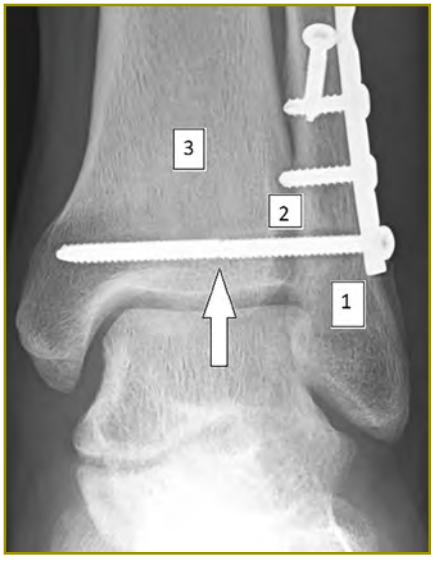

Figure 1. Anteroposterior view of the ankle, showing the zones of broken screws. A screw broken in zone 3 is marked (arrow).

Surgical Technique

After reduction and fixation of the malleolar fracture, the syndesmosis was stressed to determine instability. While fluoroscopically viewing the ankle, we evaluated internal and external stress levels and performed a Cotton test. During a Cotton test, a distraction force is applied on the fibula, with a bone hook, to attempt to separate it from the tibia. An opposing force is applied to the tibia to try to prevent tibial motion. If widening of the syndesmosis or medial clear space occurred, then reduction and fixation of the syndesmosis were undertaken. The syndesmosis was often reduced and temporarily held with a large ball-tipped, two-point reduction clamp under fluoroscopic guidance.

Fixation with screws was performed after drilling and measuring with a depth gauge. Fixation of 4 cortices was desired; however, the medial malleolar fixation occasionally prevented four cortical fixation. In these cases, three cortices were fixed. Three cortical fixation was also used when the screw system only had screw lengths in increments of 5 mm and when use of the longer screws would have resulted in excessive prominence of the thread portion medially. Screws were placed across the syndesmosis at a level that best fit the location of an empty screw hole when plate fixation of the fibula had been performed. Screws were placed centrally through the syndesmosis when there was no plate on the fibula. Most commonly, one screw was placed. Two screws were used in presence of an unfixed high fibula fracture.

Postoperatively, patients were placed in a splint that would be exchanged for a cast after 1 or 2 weeks. Patients were kept non–weight-bearing for 6 weeks; after which, patients used a walking boot and were allowed weight bearing and motion. At 12 weeks, patients gradually stopped using the cast boot. Indications for removal of syndesmotic screws were discussed, but routine removal was not performed. All patients were given subsequent follow-up appointments to evaluate their status of recovery.

Results

In addition to a syndesmosis injury, the anatomical regions of associated fractures were as follows: lateral malleolus (28 patients); medial malleolus (1 patient); medial and lateral (7 patients); medial, lateral, and posterior (1 patient); and Maisonneuve (5 patients); The remaining patients (2) had a syndesmosis injury without fracture. Most patients (28) had concomitant treatment of a lateral malleolus fracture. Table 1 describes the various methods used (labeled A through H) in treating syndesmosis injuries. Data included the number and size of syndesmotic screws, the number of cortices fixed by the screws, and whether the screw went through a plate.

Twenty-three of 44 patients had one 3.5-mm screw placed through a plate capturing four cortices (ie, method A; Table 2). Eight patients had broken screws postoperatively, and screws in two of the eight were removed owing to symptoms of pain. Another one of the eight patients with broken screws underwent operative treatment to reduce and replace the syndesmotic screws owing to notable loss of alignment with medial clear space widening. Six patients had loose screws, and one of the six had the screw removed because of pain. Four screws

were removed for pain without breaking or loosening. In total, seven of the 44 patients (16%) underwent removal of the syndesmotic screws, and one patient underwent replacement of the syndesmotic screw owing to loss of alignment.

Table 1. Description of methods used in treating 44 patients with syndesmosis injuries

Method label	No. of screws	Width of screws (mm)	Placed through a plate?	No. cortices penetrated by each screw
A	1	3.5	Yes	Four
B	1	3.5	Yes	Three
C	1	3.5	No	Four
D	2	3.5	Yes	Four
E	2	3.5	Yes	Three and four
F	2	4.5	No	Four
G	2	4.5 and 3.5	No	Three and four
H	2	4.5	No	Four

Six patients had less than 3 months of follow up and are not included in Tables 3 and 4. Screws broke in a total of eight patients (Table 3). Five had been fixed by method A and one each by method B, C, and D. Two of the eight patients had broken screws removed owing to pain, and one had the screw replaced after loss of alignment. One screw broke in zone 1, three screws broke in zone 2, and two screws broke in zone 3. One patient had one screw break in both zones 1 and 3. One patient had two screws break, each in different zones.

A loose screw was noted in one patient with developed syndesmotic widening (Figures 2 and 3). Six patients had loose screws with similar syndesmotic widening (Table 4). Four of these patients were treated using method A. Despite the loosening seen in radiographs, the self-reported pain level of patients at final follow-up was low.

Table 5 compares results of using one versus two screws; two 3.5-mm screws versus two 4.5-mm screws; and one 3.5-mm screw through four cortices versus three cortices at greater than 3-month follow-up. Fifteen of the 29 patients (52%) with one screw were reported with broken, loose, or removed screws, whereas three of the nine patients (33%) with two screws had similar outcomes. Thirteen of the 24 patients (54%) who had screws that penetrated four cortices were noted with broken, loose, or removed screws (versus two of the five patients [40%] with three cortices).

Table 2. Treatment of syndesmosis injuries in 44 patients, with corresponding numbers of patient treated per method, postoperative follow-up times, and patients with broken screws, loose screws, and removed screws[a]

Treatment method[b]	No. Patients	Follow-up, month[c]				Patients with broken screws[d]	Patients with loose screws[e]	Patients with removed screws[f]
		<3	3-6	6-9	>9			
A	23	4	9	3	7	5	4	3
B	5	0	2	2	1	1	1	0
C	5	0	4	1	0	1	0	0
D	4	0	2	1	1	1	0	0
E	3	2	1	0	0	0	0	0
F	2	0	0	1	1	0	0	0
G	1	0	0	0	1	0	0	1
H	1	0	0	1	0	0	1	0
Totals	**44**	**6**	**18**	**9**	**11**	**8**	**6**	**4**

[a] Eight procedures were performed to remove (seven) or replace (one) syndesmotic screws.
[b] Descriptions of each method are defined in Table 1.
[c] Values in columns represent the number of patients within each follow-up group (ie, in Method A, four patients had < 3 months of follow-up).
[d] Of the eight patients with broken screws, two underwent removal of screws.
[e] Loose screws were not broken. One patient underwent screw removal.
[f] Removed screws were not loose or broken. One patient underwent screw replacement.

Table 3. Analysis of broken screws in eight patients

Treatment method[a]	Zone of screw breakage	Associated fracture	Postoperative month noted	Outcome of screw	Final follow-up, month
A	3	LM	4	Removed (pain)	9
A	1 and 3	LM	5	Not removed	5
A	1	LM	5	Not removed	5
A	2	LM	4	Removed (pain)	9
A	3	LM	3	Replaced	13
B	2	LM	2	Not removed	4
C	2	Medial and LM	7	Not removed	7
D	2 and 3	Isolated syndesmosis injury	4, 5	Not removed	17

LM, lateral malleolus.
[a] Descriptions of each method are defined in Table 1.

Table 4. Analysis of loose syndesmotic screws in six patients

Treatment method[a]	Postoperative month[b]	Final follow-up, month	Self-reported pain level at final follow-up[c]
A	2	3	0
A	2	4	0
A	18 (not 3)	18	0
A	12 (not 6)	14	0[d]
B	4	5	1
H	3	6	0

[a] Descriptions of each method are defined in Table 1.
[b] The syndesmotic screwed was viewed on a radiograph obtained at this month.
[c] The scale defined 0 as the lowest level of pain and 10 as the highest.
[d] The screw was removed in this patient.

Table 5. Results of using one versus two screws; two 3.5-mm screws versus two 4.5-mm screws; and one 3.5-mm screw through four cortices versus three cortices[a]

Variable (No. patients)	Broken screws	Loose screws	Removed screws
One screw (29)	7	5	3
Two screw (9)	1	1	1
Two 3.5-mm screws (5)	1	0	0
Two 4.5-mm screws (3)	0	0	1
Four cortices (24)	6	4	3
Three cortices (5)	1	1	0

[a] Data was obtained at > 3 month follow-up.

Figure 2. Postoperative radiogrpah, showing the syndesmosis fixed with one 3.5-mm screw through the fibula plate capturing four cortices.

Figure 3. Same patient as in Figure 2 but at 10 months postoperatively, with loosening of the syndesmosis screw and slight widening of the syndesmosis (arrow). Note the lucency surrounding the screw, which no longer penetrates four cortices.

Discussion

Studies continue to debate the most successful method in treating injuries to the distal tibiofibular syndesmosis. This multifaceted debate has centered on issues such as whether syndesmotic screws should be routinely removed, how the foot should be positioned during screw placement, and the proper trajectory of screws.[10] There is no consensus on seemingly simple matters such as the number of screws, number of cortices to be engaged, or the diameter of screws to use.[11]

Once surgical fixation is achieved, the surgeon can plan for scheduled removal of syndesmotic screws or choose to forego removal unless the hardware results in symptoms of pain.[12] Advocates for routine removal have argued that it facilitates physiologic motion at the syndesmosis.[13,14] Furthermore, Manjoo et al[15] noted slightly worse functional outcomes in patients with intact screws compared to patients with broken, loosened, or removed screws. Yet Kaftandziev et al[16] reported no statistically significant differences in clinical outcome between patients with removed or retained syndesmotic screws. The findings of our study suggest that a small proportion of screws break or loosen, and not all of these caused pain or required removal. Unbroken screws that resulted in pain were also rare.

We did note one patient who lost acceptable alignment of the syndesmosis after the screws broke, and six patients with loose screws had syndesmotic widening. These findings are congruent with two papers describing how screw removal resulted in subsequent syndesmosis widening.[17,18] However, a more recent report by Gennis et al[3] found that the mortise remained radiographically intact without syndesmosis widening after weight bearing, regardless of whether syndesmotic screws were removed, loosened, or broken, or remained intact and in place. Our data, consistent with recent trends of loosening or breakage, do not support a clearly defined advantage to routine screw removal. We assert the risks and costs associated with an additional procedure for routine removal are likely unnecessary, but we do advocate for removal when the screws result in symptoms of pain. Also, our treatment method was modestly heterogeneous. The data intimated clinical outcomes were similar regarding factors such as cortices crossed, number of screws used, or whether a screw was placed through a plate,

This study had limitations. This was a retrospective, nonrandomized case series of a single surgeon. Although 44 patients were included in the study, a larger sample size would enable more confidence regarding a representative sample of the population served. There was no precisely defined protocol during the study period. We are, however, confident that the process of shared decision making between the senior author and patient falls within the scope of standard of care. Additionally, there was a relatively short follow-up period and lack of statistical significance between techniques owing to the small number of patients that underwent some of the fixation methods. Subsequently, no definitive conclusion can be made regarding what is the best technique and ultimate outcome of syndesmotic screws

However, the results of the current study provide some informative data regarding our experience with syndesmosis fixation. In general, patients seemed to have promising short-term clinical outcomes even in the presence of broken or loose screws. The number of our patients who developed broken or loose screws or who had screw removal owing to pain was previously unknown to us. Most of the broken and loose screws did not require removal. When results of studies fail to provide decisive treatment recommendations, expert opinion—rooted in the surgical experience reported here—can greatly assist practicing orthopedists.

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Conflict of Interest

The authors report no conflicts of interest.

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