Ankle Fracture Syndesmosis Fixation and Management: The Current Practice of Orthopedic Surgeons

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Abstract

There is a wide variety of treatments for disruption of the syndesmosis. There is also controversy as to which device should be used for fixation of the syndesmosis, how many devices should be used, how many cortices the screws should engage, and whether, when, and where the screws should be removed.

We conducted a study to determine how orthopedic surgeons manage these injuries. In a survey, we asked orthopedic trauma and foot and ankle fellowship directors and members of the Orthopaedic Trauma Association and the American Orthopaedic Foot and Ankle Society how they routinely treated the syndesmotic injury component of Danis-Weber type C or Lauge-Hansen pronation-external rotation type IV ankle fractures.

The overall response rate was 50% (77/153). Fifty-one percent of respondents routinely used 3.5-mm cortical screws, 24% routinely used 4.5-mm cortical screws, and 14% routinely used a suture fixation device. Forty-four percent of respondents routinely used 1 screw, 44% routinely used 2 screws, and the rest were undecided between 1 and 2 screws. Twenty-nine percent of respondents engaged 3 cortices with syndesmotic screws, and 67% engaged 4 cortices. Syndesmotic screws were routinely removed 65% of the time and left in place 35% of the time. Routine removal of syndesmotic screws was done in the operating room in 95% of cases; it was done at 3 months in 49% of cases, at 4 months in 37%, and at 6 months in 12%.

The most common method for treating syndesmotic injuries was through use of 3.5-mm screws engaging 4 cortices routinely removed in the operating room at 3 months. Number of screws used to fix the syndesmosis, either 1 or 2, was evenly split.

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Ankle fractures are the most common intra-articular fractures of a weight-bearing joint. Incidence of these fractures has increased considerably since the early 1960s.[1,2] The most common mechanism of injury is a rotational injury of the ankle, often with the distal tibiofibular syndesmosis involved. The usual mechanism of injury to the syndesmosis involves an external rotation force to the foot. Injury to the syndesmosis typically occurs with Maisonneuve fractures and Danis-Weber type C or Lauge-Hansen pronation-external rotation type IV (PER-IV) fractures. These fracture patterns include a fibular fracture above the level of the joint, though other fracture patterns without a fibula fracture may be associated with a syndesmotic injury.

The distal tibiofibular syndesmosis consists of 4 ligaments and the interosseous membrane. The ligaments are the anterior inferior tibiofibular ligament, the interosseus ligament (thickened distal portion of interosseous membrane), and the posterior inferior tibiofibular ligament and its distal portion, which constitutes the inferior transverse ligament.[3] Disruption of these structures can lead to syndesmotic instability as well as diastasis of the fibula from the tibia, which results in displacement of the talus. Computed tomography of ankle fractures with syndesmotic injury has shown that the distal fibular fragment and thus the talus are externally rotated relative to the tibia and the proximal fibular fragment.[4] As originally shown by Ramsey and Hamilton,[5] displacement of the talus by 1 mm reduces the contact area of the ankle by 42%, which can result in abnormal pressure distribution and, later, arthritis.

The goal of treatment for syndesmotic injuries is restoration and maintenance of the normal relationship between the fibula and the tibia to permit healing of the soft-tissue structures of the syndesmosis. Ankle fractures with a syndesmotic injury are usually treated surgically. The fibular fracture is usually reduced and held with a plate and screws. Reduction of the syndesmosis is achieved through a variety of techniques, but the overall goal is to restore proper length, alignment, and rotation of the fibula relative to the tibia at the distal tibiofibular joint, thus reestablishing proper positioning of the talus. This proper position is then traditionally maintained through use of screws placed from the fibula into the tibia at an angle of approximately

Table I. Respondent Demographics

Question	n (%)
Work at level I trauma center	
Yes	48 (64)
No	26 (35)
No response	1 (1)
Years in practice	
>10	53 (71)
<10	22 (29)
Previous fellowship training	
Foot and ankle	44 (59)
Trauma	21 (28)
Trauma and foot and ankle	5 (7)
Other	3 (4)
None	2 (3)

30° from posterior to anterior, parallel to and 2 to 5 cm proximal to the joint.[6,7]

Stabilization of the syndesmosis can be achieved through a variety of methods, though which is optimal is unclear. Surgeons disagree about which fixation device, either suture fixation devices or screws of various sizes and compositions, is appropriate. In addition, opinions differ regarding number of devices used, number of cortices engaged by the screws, and whether, when, and where screws should be removed. Given this considerable variety in methods of syndesmotic fixation, it is not well understood which practice is commonly used by orthopedic surgeons.

We conducted this study to determine how orthopedic surgeons routinely manage Danis-Weber type C or Lauge-Hansen PER-IV ankle fractures with syndesmotic instability. Because we felt the orthopedic surgeons most familiar with the treatment of these injuries would include those with a background in either trauma or foot and ankle surgery, we sought opinions from surgeons trained in either of these fields.

Materials and Methods

A list of all trauma fellowship directors (n = 45) was obtained from the Web site of the Orthopaedic Trauma Association (OTA), and a list of all foot and ankle fellowship directors (n = 40) was obtained from the Web site of the American Orthopaedic Foot and Ankle Society (AOFAS). We e-mailed these 85 directors and asked them to participate in our survey. On the survey, they were asked how they routinely managed fixation of the syndesmosis for type C/PER-IV ankle fractures. They were also asked to provide demographic information, including name, location, years in practice, previous fellowship training, and whether they were working at a level I trauma center. In addition, they were asked what type of and how many fixation devices they used, how many cortices of fixation they used per screw, whether they routinely removed fixation devices, and when and where they removed them. They responded by e-mail, fax, or mail. After 1 month, all nonresponders were contacted again, and another 68 OTA and AOFAS members were contacted. Total number of people contacted was 153, and total number of respondents was 77, for an overall response rate of 50%. Two surveys were incomplete and excluded from the study, leaving 75 valid survey responses.

Results

Survey respondents' demographic information is listed in Table I. Analysis revealed that some respondents did not manage all type C/PER-IV ankle fractures the same and that the treatment they used varied from patient to patient. Of the 75 respondents, 19 (25%) reported routine use of more than one type of device for stabilization of the syndesmosis. Device selection, number of devices, and number of cortices engaged by screws depended on different patient variables, including body habitus, activity level, fracture pattern, and degree of instability. However, 75% of respondents routinely used the same method of fixation for the syndesmosis in type C/PER-IV ankle fractures. Table II lists fixation methods by respondents. Responses that listed multiple device types received partial credit for each device type, and this was used to determine overall use of each fixation method.

Number of devices used for syndesmosis stabilization was evenly split, with 33 (44%) of the 75 respondents routinely using 1 device and another 33 (44%) routinely using 2 devices; the remaining 9 respondents (12%) used either 1 or 2 devices, depending on the patient. Of the 75 respondents, 69 potentially opted to use screws for fixation, and only their responses were included in the analysis of number of cortices engaged; excluded were 5 respondents who used only the Tightrope (Arthrex, Naples, Fla) and 1 who used Kirschner wires (K-wires). Twenty (29%) of the 69 respondents engaged 3 cortices with screws, 46 (67%) engaged 4 cortices, and 3 (4%) engaged 3 or 4 cortices, depending on the situation. Then, number of tibial cortices routinely engaged by each respondent was determined. Respondents who used 1 tricortical syndesmotic screw engaged 1 tibial

Table II. Method of Syndesmotic Fixation: Device Types Used

Respondents Who Used ...	n (%)
Only 1 device type	**56 (75)**
3.5-mm screw	32 (43)
4.5-mm screw	14 (19)
4.0-mm screw	2 (3)
4.0-mm cannulated screw	1 (1)
TightRope (Arthrex, Naples, Fla)	5 (7)
Bioabsorbable screw	1 (1)
Kirschner wire	1 (1)
More than 1 device type	**19 (25)**
3.5-mm screw or TightRope	4 (5)
4.5-mm screw or TightRope	4 (5)
3.5- or 4.5-mm screw	2 (3)
3.5- or 4.0-mm screw	2 (3)
3.5-mm or bioabsorbable screw	1 (1)
6.5- or 4.0-mm screw	1 (1)
Bioabsorbable screw or TightRope	1 (1)
3.5- or 4.5-mm screw or TightRope	2 (3)
3.5- or 4.5-mm or bioabsorbable screw or TightRope	2 (3)

Table III. Method of Syndesmotic Fixation: Number of Devices Used and Number of Cortices Engaged Per Screw

	n (%)
Fixation devices	75
1	33 (44)
2	33 (44)
1 or 2	9 (12)
Cortices engaged[a]	69
3	20 (29)
4	46 (67)
3 or 4	3 (4)

[a]Includes responses indicating use of screws and excludes responses indicating use of Kirschner wires or only TightRope.

Table IV. Timing of Screw Removal (n = 43[a])

Months	n (%)
3	21 (49)
4	16 (37)
6	5 (12)
4-6	1 (2)
12	0 (0)

[a]Includes only those respondents who routinely removed screws.

cortex, those who used 2 tricortical syndesmotic screws or 1 quadricortical screw engaged 2 tibial cortices, and those who used 2 quadricortical syndesmotic screws engaged 4 tibial cortices. Again, to determine overall number of tibial cortices engaged, we gave partial credit to respondents who varied either the number of screws or the number of cortices engaged. Overall, 13 (19%) of the 69 respondents engaged 1 tibial cortex with a single tricortical syndesmotic screw, 30 (43%) engaged 2 tibial cortices with either 2 tricortical screws or one quadricortical syndesmotic screw, and 26 (38%) engaged 4 tibial cortices with 2 screws (Table III).

Of the 69 respondents who potentially used screw fixation, 66 were included in the analysis of routine screw removal; excluded were 2 respondents who used absorbable screws (not routinely removed) and 1 person who provided an invalid response. Twenty-three (35%) of the 66 respondents opted to not remove the syndesmotic screws; 43 (65%) opted for routine removal. Table IV indicates when the latter respondents removed screws. Of the 43 screws removed, 41 (95%) were removed in the operating room, and 1 (2%) was removed in the clinic; 1 person (2%) did not respond to this question.

Discussion

Type C/PER-IV fractures, ankle fractures with injury to the syndesmosis, are commonly treated by orthopedic surgeons. The treatment methods used are numerous, and new techniques are being developed. Treatment is covered abundantly in the literature, but, because of the lack of controlled studies, there is no consensus as to the proper method for stabilizing the syndesmosis. In addition, there is controversy regarding implant selection, number of implants used, number of cortices engaged, and necessity and timing of implant removal. The purpose of this study was to determine how knowledgeable orthopedic surgeons are addressing these issues when treating a typical type C/PER-IV ankle fracture.

Screw Selection

Metal screws traditionally are used for syndesmotic fixation, but there is considerable variability in screw selection.

Cannulated Screws. Some surgeons use cannulated screws for ease of placement, but this advantage comes at an increased cost (cannulated screws can cost $160 to $175 more than standard screws). Another drawback is that fatigue strength is lower for cannulated screws than for noncannulated screws of similar diameter.

Screw Size. In addition, there are a variety of screw sizes, and, in this survey, screws of 4 different sizes (3.5, 4.0, 4.5, 6.5 mm) were used to fix the syndesmosis, with larger screws theoretically providing increased stability. Also, larger screw heads are more easily palpable, which can facilitate removal in the clinic; according to our survey, however, 95% of screws (regardless of size) are removed in the operating room. At the same time, larger screws are more likely to be prominent and cause discomfort. Also, when screws are not removed before full weight-bearing, they may loosen or break as the ankle regains its normal range of motion. It is thought that smaller (3.5-mm) screws are more likely to loosen and larger (4.5-mm) screws are more likely to break.[1,2]

In a cadaveric study, 3.5- and 4.5-mm screws were found to have similar biomechanical properties and the ability to resist axial and rotational forces.[8] Also, costs are similar ($20) for standard 3.5- and 4.5-mm screws. The benefits of using 3.5-mm screws include less prominent hardware, less perceived need for routine hardware removal,[9] potentially less damage with screw loosening,[1] and ability to use a size that is the same as that of the other implants used to fix the fibula. All these benefits may account for why 3.5-mm screws are the most popular implants used by our survey respondents; 51% of the respondents routinely used 3.5-mm screws for syndesmosis fixation. However, 3.5-mm screws clearly have inferior fatigue performance when compared with 4.5-mm screws, which could influence mode of failure in these cases. It should be noted that use of K-wires for stabilization of the syndesmosis (1 respondent's method) has been found comparable with use of a 3.5-mm screw with 2 oblique K-wires.[10]

Number of Screws and Cortices. Increased stiffness and resistance to external rotation are achieved with the use of 2 screws[11] and with 4 cortices engaged, instead of 3 cortices engaged with a syndesmotic screw. Whether the benefit of improved syndesmotic stability results in improved clinical outcome is unclear.[3] Many surgeons feel it is important to allow more physiologic (fibular) motion, so they advocate only 3 cortices of fixation. Other authors believe that loosening is more likely when screws engage only 3 cortices of fixation as opposed to 4 cortices.[1-3] Another benefit of engaging 4 cortices is that removal of a broken screw is easier. Our survey showed that respondents were divided down the middle with regard to how many implants they used to stabilize the syndesmosis. Forty-four percent routinely used 1 implant, and 44% routinely used 2 implants; the remaining 12% stated that sometimes they used 1 screw, sometimes 2 screws (it depended on the situation). This finding showed that there was no clear preference and that surgeons may choose to use an additional screw when increased syndesmotic stability is desired. Sixty-seven percent of respondents engaged 4 cortices, likely because of several factors, including ability to achieve a lateral buttress, increased stability in cases of extreme comminution and/or poor bone quality, and ease of removal of a broken screw.[9] It is interesting to see how many tibial cortices were engaged by syndesmotic screw fixation. For fixation, it is possible that many surgeons do not feel comfortable engaging only 1 tibial cortex with 1 tricortical screw. Only 19% of respondents used 1 syndesmotic screw to engage 3 cortices, compared with 43% who used either 2 tricortical screws or 1 quadricortical screw and 38% who used 2 quadricortical screws. Therefore, 81% of respondents achieved stabilization of the syndesmosis by engaging at least 2 tibial cortices.

Remove Syndesmotic Screws? Another consideration for managing type C/PER-IV ankle fractures is whether the syndesmotic screws should be removed. Some authors have advocated removing screws to restore the normal biomechanics of the syndesmosis, particularly when using a stiffer construct.[1-3,9] Others have advocated leaving the syndesmotic screws in place, but this can lead to loosening or breakage.[1-3,9] Several authors have indicated that hardware failure or screw breakage is uncommon[1,2,9,12] and seldom symptomatic, and there appear to be no significant consequences of screw breakage. Screw loosening appears to be a more likely consequence of allowing syndesmotic screws to remain after initiating full weight-bearing, and screw loosening has been shown to have a minimal effect on clinical outcome.[13] When syndesmotic screws are removed too early, however, there is increased risk for syndesmotic diastasis recurrence.[14] As a result, it is recommended that screws be left in place for 12 weeks (or 3 months), and our study showed that 86% of surgeons who routinely removed the syndesmotic screw(s) did so at 3 months (49%) or 4 months (37%). Our survey also indicated that 43 (65%) of 66 surgeons who used metal screws for syndesmotic fixation routinely removed the screws, and, in 41 (95%) of those 43 cases, screws were removed in the operating room. This practice increases the costs and risks associated with a second surgical procedure, including risks for anesthesia and infection. The additional cost for removal of hardware from the ankle was estimated to be more than $500 in a 1996 study[15] and is considerably more today.

Some newly developed implants do not need to be removed to restore the normal biomechanics of the syndesmosis. These implants include bioabsorbable screws and suture fixation devices such as the TightRope (Arthrex, Naples, Fla). The bioabsorbable screw undergoes hydrolysis and resorbs over time until eventually it is no longer strong enough to prevent physiologic motion at the syndesmosis. Several studies have shown that bioabsorbable screws have favorable outcomes when used for syndesmotic fixation.[16-18] In addition, because bioabsorbable screws are not routinely removed, there are no costs for a second surgery. Our survey indicated a 65% (43/66) rate of routine removal of metal syndesmotic screws, so a more expensive implant that is not routinely removed is cost-effective.

> **"We found that the most commonly used fixation method was one or two 3.5-mm screws engaging 4 cortices."**

This finding would also pertain to the suture button fixation device (current cost, $400). Findings from a cadaveric study[19] and a clinical trial[20] suggest that this implant can be used as an alternative to screws for syndesmotic fixation. Possible advantages of this implant are no need for routine removal and less rigid fixation allowing for physiologic motion at the syndesmosis; a possible disadvantage is that this implant could cause syndesmosis overtightening. Findings from recent studies suggest that compression at the syndesmosis does not have a deleterious effect on ankle motion.[21]

A considerable amount of research has been devoted to the potential use of bioabsorbable screws, but, according to our survey, only 1 person (1%) routinely used a bioabsorbable screw for syndesmotic fixation, and only another 4 (5%) would consider using a bioabsorbable screw, depending upon the particular patient situation. The overall result is that only 7% of orthopedic surgeons may potentially use a bioabsorbable implant for these injuries. On the other hand, only 4 reports on suture fixation of the syndesmosis have been published, so data are lacking.[7,19,20,22] Of these 4 reports, only 2[19,20] pertained to a currently commercially available suture button fixation device. It is interesting that this device was the third most common method of syndesmotic stabilization in our survey. Five (7%) of our 75 respondents routinely used this device, and another 13 (17%) used it in certain situations—for a total rate that is considerably higher than the rate for use of bioabsorbable screws. Use of bioabsorbable screws may not be common because of the difficulty in acquiring them[3] and because of possible adverse tissue reactions to the materials, polylactic acid and polyglycolic acid.[23]

About the Respondents

To ensure that our respondents were knowledgeable about treatment of type C/PER-IV ankle fractures and had an interest in either orthopedic trauma surgery or orthopedic foot and ankle surgery, we contacted only the directors of trauma and foot and ankle fellowships along with other select OTA and AOFAS members whose contact information was listed in certain orthopedics publications. In addition, experience was determined by how long respondents had been in practice and whether they were working at a high-volume trauma center. Sixty-four percent of respondents were working at a level I trauma center, and 71% had been in practice for more than 10 years. Unfortunately, the questionnaire response rate was only 50%, which may have affected our results, though we believe it is unlikely that the practice pattern of nonresponders would have differed from that of our respondents. All but 3% of respondents were fellowship trained, and 70 (93%) of 75 respondents completed a trauma fellowship, a foot and ankle fellowship, or both, which indicates a high degree of expertise. Although more respondents were trained in foot and ankle than in trauma, there were no obvious difference in their practice patterns. However, the number of survey responses was small, and it is possible that practice pattern differences could become apparent with a larger number of responses.

Conclusions

We found that the most commonly used fixation method was one or two 3.5-mm screws engaging 4 cortices. In addition, screws were removed in the operating room, usually 3 months after initial surgery. These findings do not mean that this method for treating syndesmotic injuries is the optimal one. More randomized controlled clinical trials are needed to determine the optimal method.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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This paper will be judged for the Resident Writer's Award.