The Development of Heterotopic Ossification Following Ankle Fracture Syndesmotic Screw Fixation
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Introduction/Purpose: Syndesmotic fixation with screws is commonly used for ankle fractures with syndesmotic disruption. Few studies have reported the development of heterotopic ossification (HO) within the syndesmosis following ankle injuries, which may lead to abnormal joint kinematics and even joint synostosis. However, there is little data on the prevalence and on the risk factors associated with the development of HO. The purpose of this study is to determine the (1) prevalence and (2) risk factors associated with the development of HO within the distal tibiofibular syndesmosis following ankle fractures requiring syndesmotic fixation. We hypothesized that screws within the syndesmosis articulation and broken screws would be associated with a higher incidence of HO than extraarticular and intact screws, respectively.

Methods: A retrospective review was conducted for patients who sustained an ankle fracture with syndesmotic disruption. Inclusion criteria: age between 18 and 65 years old, a closed ankle fracture treated operatively with syndesmotic screw fixation. Exclusion criteria: additional lower extremity injury, history of prior ankle fracture, lack of radiographic follow-up and fixation other than 1 or 2 syndesmosis screws. Medical records were reviewed for: age, sex, high or low energy injury mechanism, smoking status, diabetes, BMI, perioperative complications, and further procedures. Fractures were classified by Lauge-Hansen and Weber systems. Immediate postoperative radiographs were reviewed for the number of syndesmotic screws, whether screws were intraarticular or extraarticular and the number of cortices each screw crossed. Final postoperative radiographs were reviewed for retention or screw removal and the presence of HO. The presence of HO was defined as new or increased bone formation within the syndesmosis compared to immediate postoperative radiographs.

Results: Included were 264 patients, mean radiographic follow-up of 10.5 +/- 10.2 months. The mean age was 39.2 +/- 12.6 years (38.7% female) with a mean BMI of 32.1 +/- 7.8. Current smokers made up 39.4% of patients and 10.6% were diabetic. The mean time to fracture fixation was 12.6 +/- 3.2 days and 198 patients (75%) had a low energy injury. There was no significant difference in HO formation for demographics, injury mechanism or time to fixation. Overall, HO developed in 160 patients (60.6%). There was no difference, additionally for fracture pattern, number screws or fixation construct (Table 1). HO developed in 92% of broken, 75% of loose and 44% of intact screws (P<0.001). Screws were removed in 107 patients (40.5%) with no difference in HO formation compared to patients with intact screws.

Conclusion: Heterotopic ossification is commonplace following screw fixation for syndesmotic injuries with a prevalence of 60.6%. Broken screws and loosened screws are a significant risk factor for the development of HO. However, no other risk factors in this study were found to be associated with the development of HO, including intraarticular syndesmotic screw placement. Patients should be counseled on the prevalence although further research is needed to determine the effect on ankle motion and progression of post-traumatic osteoarthritis.
| Injury Classification                        | All Patients (n=264) | Development of HO |  |  |
|---------------------------------------------|----------------------|-------------------|---|---|
|                                             | % (n)                | % (n)             | % (n) | P-value |
| Weber B                                     | 49.6% (131)          | 55.7% (73)        | 44.3% (58) | 0.306  |
| Weber C                                     | 34.5% (91)           | 64.8% (59)        | 35.2% (32) |  |
| Maisonneuve                                 | 12.1% (32)           | 62.5% (20)        | 37.5% (12) |  |
| Syndesmosis injury w/o fibula fracture      | 3.8% (10)            | 80.0% (8)         | 20.0% (2)  |  |
| Fracture Anatomy                            |                      |                   |     |  |
| Fibula                                      | 41.7% (106)          | 67.0% (71)        | 33.0% (35) | 0.084  |
| Fibula + Medial Malleolus                   | 16.1% (41)           | 46.3% (19)        | 53.7% (22) |  |
| Fibula + Posterior Malleolus                | 20.9% (53)           | 52.8% (28)        | 47.2% (25) |  |
| Trimalleolar                                | 21.3% (54)           | 63.0% (34)        | 37.0% (20) |  |
| Number of Fixation Screws                   |                      |                   |     |  |
| 1                                           | 26.5% (70)           | 58.6% (41)        | 41.4% (29) | 0.684  |
| 2                                           | 73.5% (194)          | 61.3% (119)       | 38.7% (75) |  |
| Number of Intraarticular Screws             |                      |                   |     |  |
| 0                                           | 51.5% (136)          | 63.2% (86)        | 36.8% (50) | 0.527  |
| 1                                           | 42.4% (112)          | 58.9% (66)        | 41.1% (46) |  |
| 2                                           | 6.1% (16)            | 50.0% (8)         | 50.0% (8)  |  |
| Fixation Construct                          |                      |                   |     |  |
| One tricortical                             | 11.7% (31)           | 67.7% (21)        | 32.3% (10) | 0.198  |
| One quadricortical                          | 14.8% (39)           | 51.3% (20)        | 48.7% (19) |  |
| One tricortical, one quadricortical         | 18.2% (48)           | 56.3% (27)        | 43.7% (21) |  |
| Two tricortical                             | 22.7% (60)           | 71.7% (43)        | 28.3% (17) |  |
| Two quadricortical                          | 32.6% (86)           | 57.0% (49)        | 43.0% (37) |  |
| Screw Removal                               |                      |                   |     |  |
| Removed                                     | 40.5% (107)          | 62.6% (67)        | 37.4% (40) | 0.581  |
| Retained                                    | 59.5% (157)          | 59.2% (93)        | 40.8% (64) |  |
| Screw Status                                |                      |                   |     |  |
| Broken                                      | 27.7% (73)           | 91.8% (67)        | 8.2% (6)  | <0.001 |
| Loosened                                    | 10.6% (28)           | 75.0% (21)        | 25.0% (7)  |  |
| Intact                                      | 61.7% (163)          | 44.2% (72)        | 55.8% (91) |  |

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