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Technical aspects of the syndesmotic screw and their effect on functional outcome following acute distal tibiofibular syndesmosis injury

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ABSTRACT

Introduction: Much of the currently available data on the technical aspects of syndesmotic screw placement are based upon biomechanical studies, using cadaveric legs with different testing protocols, and on surgeon preference. The primary aim of this study was to investigate the effect of the level of syndesmotic screw insertion on functional outcome. Further, the effects of number of cortices engaged, the diameter of the screw, use of a second syndesmotic screw and the timing of removal on functional outcome were tested.

Material and method: All consecutive patients treated for an ankle fracture with concomitant acute distal tibiofibular syndesmotic injury that had a metallic syndesmotic screw placed, between 1 January 2004 and 31 December 2010, were included. Patient characteristics (i.e., age at injury and gender), fracture characteristics (i.e., affected side, trauma mechanism, Weber fracture type and number of fractured malleoli), and surgical characteristics (i.e., level of screw placement, screw diameter, tri- or quadricortical placement, number of syndesmotic screws used and the timing of screw removal) were recorded. Outcome was measured using validated questionnaires, which were sent by post, and consisted of the American Orthopaedic Foot and Ankle Society ankle-hindfoot score (AOFAS), the Olerud–Molander Ankle Score (OMAS) and a single question Visual Analog Scale (VAS) for patient satisfaction with outcome.

Results: During the 7-year study period, 122 patients were treated for syndesmotic injury. A total of 93 patients (76%) returned the questionnaire. The median follow-up was 51 months. The outcome scoring systems showed an overall score for the entire group of 92 points for the AOFAS, 77 for the OMAS and 8.2 for the VAS. Outcome was statistically significantly influenced by the number of fractured malleoli, age, trauma mechanism and the level of screw insertion.

Conclusion: Overall, the functional outcome of acute syndesmotic injuries treated with a syndesmotic screw was good and mainly influenced by patient and fracture characteristics. Most different technical aspects of placement appeared not to influence these results. Only screw placement above 41 mm negatively influenced outcome.

The distal tibiofibular syndesmosis stabilises the ankle joint, which as a dynamic system allows motion of the fibula in relation to the tibia in all directions. The syndesmosis consists of the anterior inferior tibiofibular, the interosseous ligament and membrane, the posterior inferior tibiofibular and the inferior transverse ligament. Each of these ligaments contributes to the stability between 9% and 35% [1,2]. Rupture of two or more of these ligaments may lead to instability [3].

The most recent biomechanical analysis of fibular motion with an intact syndesmosis showed an anterior/posterior translation of 1.5 mm, a cranial movement of 0.5 mm and a lateral movement of 2 mm during each plantar to dorsi-flexion of the ankle. When looking at rotation the most pronounced motion is a 4° rotation around the fibular axis [4].

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It is estimated that 10% of all ankle fractures and 20% of the surgically treated fractures have a concomitant syndesmotic injury. In Weber C-type fractures (Lauge-Hansen Pronation ExoRotation (PER)), a syndesmotic disruption should be assumed [5–8]. In Weber B-type (Lauge-Hansen Suppination-ExoRotation (SER) and pronation-abduction (PA)), the percentages of syndesmotic involvement range widely between 19% and 85% [9–13].

Upon diagnosis, proper treatment is warranted for favourable outcome. However, much of the data currently available on the technical aspects are based upon biomechanical studies using cadaveric legs with different testing protocols, and on expert opinions. Even though treatment is partially influenced by type of fracture and level of fracture, a large proportion of the management is based on surgeon preference. The primary aim of this study was to investigate the influence of the level of syndesmotic screw insertion on functional outcome. Secondly, the effect of the number of cortices engaged, the diameter of the screw, use of a second syndesmotic screw and timing of removal were tested.

Material and method

All consecutive patients treated for an ankle fracture with concomitant acute distal tibiofibular syndesmotic injury that had a metallic syndesmotic screw placed, between 1 January 2004 and 31 December 2010, were included. Patients were treated at a single large level-2 trauma centre. Patients in whom a bioresorbable screw was used ($n = 4$), who had died ($n = 1$) or who had severe mental impairment ($n = 2$) were excluded from participation.

Syndesmotic screws were placed upon stress testing using the hook test or the external-rotation stress test. The screw was placed either through the plate in Weber-B fractures or below the plate or individually in higher Weber-C fractures. Two syndesmotic screws were placed in Maisonneuve fractures, or when deemed necessary by the attending surgeon to increase the construct stability. The screw was angled at 30° with the foot in 90° or in a more neutral position. The screw diameter, level of placement, number of engaged cortices and timing of removal were at the discretion of the surgeon (Fig. 1). According to hospital protocol, patients received a postoperative non-weight-bearing splint for 2 weeks, followed by a wound check and, depending on fracture type, a weight-bearing (in case of unimalleolar injuries) or non-weight-bearing (in case of bi- or trimalleolar fractures) short leg cast for 4 weeks. After screw removal, patients were allowed full weight-bearing. Removal of syndesmotic screws between 6 and 8 weeks was standard practice, as propagated by the Arbeitgemeinschaft fur Osteosynthesefragen (AO). Patient characteristics (i.e., age at injury and gender), fracture characteristics (i.e., affected side, Weber fracture type, trauma mechanism and number of fractured malleoli) and surgical characteristics (i.e., level of screw placement, screw diameter, tri- or quadricortical placement, number of syndesmotic screws used and the timing of screw removal) were recorded from the patient files and the Picture Archiving and Communication System (PACS Kodak Carestream, Rochester, NY, USA). The trauma mechanism was classified as low-energy trauma (i.e., sporting injury and sprain-like (supination) injury) or high-energy trauma (i.e., fall from height and traffic injury).

The level of screw placement was measured from the tibial pilon (joint line) to the centre core of the screw. In case of placement of two screws, the lowest screw was measured. Measurements were made in two consecutive radiographs (direct post-operative and at first appointment at the outpatient department); these two values were averaged to correct for slight differences in radiographic projection. The level of the syndesmotic screw was than classified into three groups according to the AO recommendations: 1) 0–20.99 mm above the tibia joint line or transsyndesmotic, 2) 21–40.99 mm and 3) 41–60 mm. Timing of removal was divided into three groups according to findings of previous studies on syndesmotic screw removal: 1) <8 weeks, 2) ≥ 8 weeks, 3) still in place at follow-up [14,15].

Outcome measurement

Outcome was measured using validated questionnaires, which were sent by post in April 2012 after a minimum follow-up of 18 months and consisted of the American Orthopaedic Foot and Ankle Society ankle-hindfoot score (AOFAS), the Olerud–Molander Ankle Score (OMAS) and a single-question Visual Analogue Scale (VAS) for patient satisfaction with outcome. A reminder was sent to patients who had not responded after 4 weeks. The OMAS is a self-administered patient questionnaire with a score of zero (totally impaired) to 100 (completely unimpaired) and is based on nine different items: pain, stiffness, swelling, stair climbing, running, jumping, squatting, sports and work/activities of daily living [16]. The AOFAS ankle-hindfoot score includes nine questions related to three components: pain (one question; 40 points), function (seven questions; 50 points) and alignment (one question; 10 points) leading to a total possible score of 100 points. The question related to alignment and range of motion was completed by a physician based upon patient files and radiographs; the other questions were completed by the patient. A VAS was used to measure overall satisfaction of patients with outcome (range 0–10).

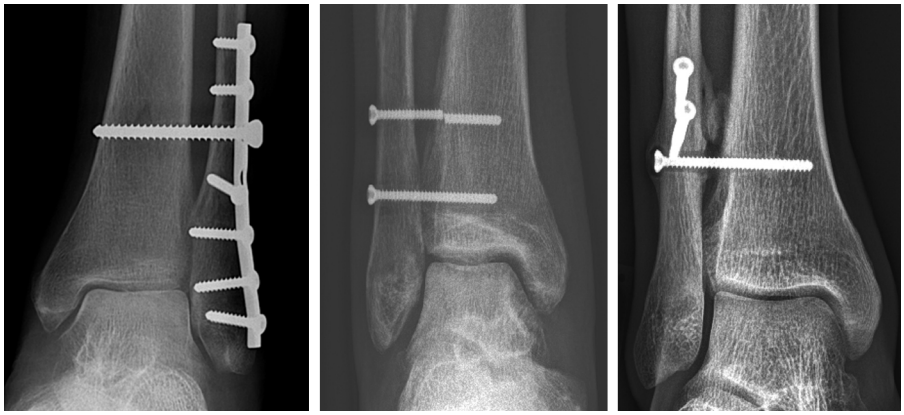

Fig. 1. Three examples of the different syndesmotic screw placement strategies a. A 4.5 screw placed above 40.99 mm quadricortically b Two 3.5 screws with most distal one placed below 21 mm tricortically c. Single 3.5 screw placed between 21 and 40.99 mm tricortically.