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Original article

## Tibiofemoral syndesmosis injury treated by temporary screw fixation and ligament repair

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### ABSTRACT

**Introduction:** Tibiofemoral syndesmosis injuries are common but have not been extensively researched. The primary objective of this study was to evaluate the outcomes after temporary screw fixation with ligament repair of these injuries. The secondary objective was to look for factors that could impact these outcomes. We hypothesised that this double fixation (screw + suture) would lead to good outcomes with minimal secondary opening of the syndesmosis upon screw removal.

**Material and methods:** This was a retrospective study of 285 patients with a tibiofemoral syndesmosis injury (01/2004–12/2011) who were treated by temporary tricortical or quadricortical screw fixation and ligament repair. The operated leg was unloaded for 6–8 weeks postoperative with the patient wearing a walking cast. The screw was removed in all patients before weight bearing was allowed. At follow-up, the range of motion, return to sports, pain, and functional scores (AOFAS and OMAS) were determined, and a radiological assessment was performed.

**Results:** One hundred twenty-six patients were reviewed after a mean follow-up of  $5.9 \pm 5.7$  years (2.9–10.5). Mean plantarflexion was 95% of the contralateral side and mean dorsiflexion was 93%. Return to sports occurred after a mean of 10 weeks; 83% of patients returned to their pre-injury level of participation. Pain on VAS was 0.8/10 on average. The mean AOFAS and OMAS scores were both above 90 points. At the review, 4% of screws had broken. Diastasis was found in 5.6% of cases, osteoarthritis in 6.3% and an osteophyte in 11.1% of cases, but with no clinical repercussions. No risk factors were identified.

**Discussion and conclusion:** Treatment by temporary screw fixation and ligament repair leads to good objective results, confirming our hypothesis. However, there is little published data and no consensus on the fixation method or the need to remove the screw.

**Level of evidence:** IV, retrospective, non-comparative.

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### 1. Introduction

Ankle fractures are a common condition with many anatomical variations. Gerber et al. [1] believed that tibiofemoral syndesmosis damage is underestimated. This was confirmed by Rammelt et al. [2] and Dubin et al. [3], who observed a 1–18% rate of distal tibiofemoral joint (DTFJ) injury in conditions labelled as ankle sprains. Damage to the DTFJ has been found in 23% of malleolar

fracture cases [4] and makes these fractures more difficult to treat [1,4]. But there is no consensus as to the need for surgical treatment or the need to suture the anterior talofibular ligament (ATFL). The medium-term results of surgically treated acute DTFJ injuries are satisfactory, but very few studies have been done on this topic and their follow-up is short [5,6].

The primary objective of our study was to determine the outcomes after open surgical treatment of DTFJ injuries by temporary screw fixation and ATFL repair. The secondary objective was to look for factors that could impact these outcomes. We hypothesised that the radiological and clinical outcomes would be good, highlighting the need to repair the ligament and use temporary screw fixation, with minimal secondary opening of the syndesmosis after the screw is removed.

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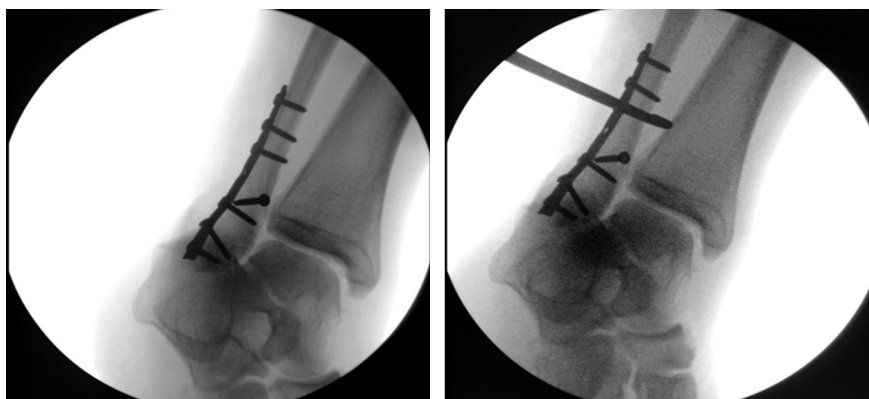


Fig. 1. Intraoperative testing.

## 2. Material and methods

### 2.1. Patients

All patients between January 1, 2004 and December 31, 2011 with an ankle fracture or isolated DTFJ injury who were treated with temporary screw fixation (3.5 mm) and ATFL repair were included. Over this period, 1394 patients were treated because of an ankle fracture; 285 of them had a DTFJ injury (20.5%). The diagnosis of syndesmosis damage was made using standard A/P and lateral views, and more specifically using a “surgical” A/P view with 20° internal rotation. The Harper and Keller X-ray diagnostic criteria for a positive diagnosis were applied [7]: tibiofibular gap >6 mm or >44% of fibula width, 1 cm above the tibial pilon. The most reliable measurement is that of the tibiofibular gap, as it is independent of the leg’s position during X-rays [8].

Patients were excluded if their medical records were incomplete ( $n = 3$ , 1%), they had a confounding lower limb injury ( $n = 4$ , 1.4%), or their surgical report did not specifically mention ATFL repair ( $n = 85$ , 30%). In all, 57 patients were lost to follow-up (28.5%), three died (1.5%) and six (3%) did not want to participate in the study. One patient with dementia (0.5%) was excluded because the clinical evaluation could not be carried out.

The analysed cohort consisted of 126 patient records: 77 men (61%) and 49 women (39%) with an average age of  $45 \pm 15.7$  at the time of surgery (16–86.5). Ninety-two patients (73%) were amateur athletes. The injury mechanism was low-energy trauma in 91 cases (72.2%) and high-energy trauma in 35 cases (27.8%). A fracture–dislocation was present in 19 cases (15%). There were 26 cases (21%) of isolated malleolar fracture (with medial ligament damage in 20 of these cases [77%]), 65 cases (52.5%) of bimalleolar fracture, 19 cases (15.3%) of trimalleolar fracture and 14 cases (11.2%) of Maisonneuve fracture.

### 2.2. Surgical technique

The malleolar fractures were secured first. Involvement of the DTFJ was confirmed intraoperatively by performing a hook test under fluoroscopy (Fig. 1). The ankle was held at 90° and the ankle mortise stabilised with pointed clamps [9,10]. The ATFL was reattached through bone tunnels with absorbable suture. A 3.5-mm screw was inserted in the reduced position, 2–4 cm above the joint line and parallel to it [9,10]. The screw had purchase in three cortices in 87 cases (69%) and four cortices in 39 cases (31%) (Fig. 2). Postoperatively, non-weight-bearing was prescribed for 6–8 weeks with use of a walking cast and preventative heparin therapy. The screw was removed in all patients at the end of the immobilisation period and rehabilitation initiated; patients were allowed to bear



Fig. 2. Right supra-tubercular bimalleolar fracture: a: preoperative; b: note the slightly low position of the syndesmosis screw, which was imposed by the fracture’s location relative to the hole in the plate (upper hole is at end of fracture).

weight as tolerated and underwent physiotherapy. Nearly 20 different surgeons performed these surgical procedures during the study period.

### 2.3. Assessment method

The following were evaluated: weather-related pain, pain on a visual analogue scale (0 to 10), plantarflexion (PF), dorsiflexion (DF), objective feelings of ankle stiffness, AOFAS [11] and OMAS [12] scores, and return to sports (time/level). Immediate postoperative and follow-up radiographs were used to evaluate the quality of the reduction, presence of secondary displacement, screw position, secondary diastasis, signs of tibiotalar osteoarthritis, presence of synostosis and time to fracture union. The screw height was measured from the tibial pilon to the middle of the screw (mm). Any complications were recorded.

### 2.4. Statistical analysis

The raw data for the quantitative variables were described with mean values ( $\pm$  standard deviation, min–max). The sample size and percentage distribution were calculated for the qualitative variables. Inferential statistical analysis was carried out using Bayesian methods [13]. Calculations were performed with the R 3.0.1 and JAGS 3.4.0 software packages. Note that Bayesian methods do not generate *P*-values.

### 3. Results

The analysed cohort consisted of 126 patients with a mean follow-up of  $5.9 \pm 5.7$  years (2.9–10.5).

#### 3.1. Complications and secondary procedures

There were no intraoperative complications, but there were 19 postoperative complications (15%), six of which were serious (4.8%). There were five infections (4%): one near the inserted screw and four after the screw was removed, including the patient who had the first infection. Surgical lavage with appropriate antibiotics and local wound care led to good outcomes in three cases. The two other infections were superficial and treated using local wound care. Significant ankle stiffness twice required open arthrolysis because of anterior bone impingement in the same patient (at 14 and 24 months); the range of motion was still limited (DF  $0^\circ$ , PF  $30^\circ$ ) at review. This stiffness had relatively significant clinical repercussions with an AOFAS score of 67 and OMAS score of 75 at review. There were also 12 cases (6% rate) of complex regional pain syndrome that resolved and one case of deep venous thrombosis.

#### 3.2. Functional, subjective and clinical outcomes

Weather-related pain was present in 28 (22%) cases and the mean VAS was  $0.8 \pm 1.3$  (0–6). Subjective stiffness was noted in 63 cases (50%). Objective range of motion measurements found that PF was  $95 \pm 10\%$  of the contralateral side on average (10–100) and DF was  $93 \pm 10\%$  of the contralateral side on average (50–100), with 18 (14.3%) patients defined as having a stiff ankle. The rehabilitation period was  $5.2 \pm 4$  weeks long on average (0–25). The mean AOFAS score was  $93 \pm 9$  (49–100) and the mean OMAS score was  $93 \pm 10$  (45–100). Among the athletes, 76 (82.6%) returned to their sport at their pre-injury level, 15 (16.4%) reduced their participation and 1 (1%) did not return to sports. The mean time away from sports was  $10 \pm 6.7$  weeks (2–48). The screw was removed in all patients in the operating suite after an average of  $7 \pm 7$  weeks (2–45).

#### 3.3. Radiological outcomes

The malleolar union rate was 97.6% in an average of  $7 \pm 7$  weeks (2–45). The screw height was  $29.5 \pm 8.7$  mm from the joint line, on average (10.1–56.2 mm). Two initially poor reductions (1.6%) were found. After 5 years of follow-up, no signs of degeneration were present. There were eight patients (6.3%) with signs of osteoarthritis; they had a mean AOFAS of 75 and mean OMAS of 72. An osteophyte was visible in 14 patients (11.1%) but it did not have any clinical repercussion; the mean AOFAS was 91 and mean OMAS was 92 in these patients. Secondary diastasis was found seven times (5.6%) (Fig. 3) with little after-effects (mean AOFAS of 87 and mean OMAS of 85). None of these patients developed osteoarthritis and none were secondary to early screw breakage ( $n=5$ , 4%). A tricortical screw broke three times and the broken end was left in place. Twice, a quadricortical screw broke and the broken end was removed with a trephine through a direct tibial approach. Secondary opening was noted at the first follow-up visit after screw removal but it had not gotten worse at the final review.

#### 3.4. Risk factors

No risk factor (age, sex, fracture type, reduction quality, time to screw removal, presence of complications, high or low-energy trauma) was identified that impacted the outcomes (functional scores, range of motion).



Fig. 3. Recurrence of diastasis in the distal talofibular joint found in the first follow-up visit after screw removal.

### 4. Discussion

Our hypothesis was confirmed over a mean follow-up of 6 years. The clinical outcomes were good: AOFAS and OMAS scores of 93 points, average DF and PF that were more than 90% of the contralateral side. There were only a few cases of secondary opening of the syndesmosis ( $n=7$ , 5.6%) on the radiological analysis, and all had acceptable functional scores. The rate of major complications (infection, significant stiffness) was relatively low ( $n=6$ , 4.8%) and few patients progressed to osteoarthritis ( $n=8$ , 6.3%) (Table 1).

However, this study has certain limitations, including its retrospective design. The large number of surgeons involved does not allow for rigorous comparisons, but it is an integral aspect of a teaching hospital and a long-duration study. Only standard X-rays were used for the radiological analysis; these are less sensitive than computed tomography for evaluating the reduction quality. Lastly, the follow-up is not long enough to truly know the radiological repercussions of poor reduction or secondary opening of the syndesmosis; however, this study had one of the longest follow-up periods of all published articles on this topic.

The fact that multiple surgical techniques have been described for syndesmosis injuries suggests that there is no proof that one technique is superior to another: use of one or two screws, metal or absorbable screw, tricortical or quadricortical screw, 3.5 or 4.5 mm diameter, or even suture repair only [16,25–27]. Few authors insist on this point, which nevertheless is essential. This implies a direct approach to the syndesmosis and is a contraindication to percutaneous surgery. There are two advantages to open surgery: the ability to remove any interposition and to have direct visual control over the reduction. The consensus location for screw insertion is 2 cm to 4 cm from the joint line [9,10], although the exact location has no effect on the clinical and radiological outcomes [15]. In practice, the chosen level is often dictated by the fracture's location. The screw diameter appears to have no effect on the occurrence of secondary displacement or stiffness [26,27]. The number of cortices that the screw should span is not set out in the literature. Moore et al. [16] found no differences between three and four-cortex constructs, but there was loss of reduction in 7% of tricortical cases when the postoperative unloading instructions were not followed. Screw fixation through a fourth cortex does not seem to improve the outcomes [17].

**Table 1**  
Outcomes of large published studies on this topic.

Authors	Year	Sample size	Type of syndesmosis treatment	Follow-up (months)	Functional outcomes	Radiological outcomes
Weening et al. [14]	2005	51	35 by 3.5 mm tricortical screw 7 by 4 mm tricortical screw 2 by 3.5 mm tricortical double screw 2 by 4.5 mm tricortical screw 5 by 3.5 mm tricortical screw	18	OMAS 74.1	3 diastasis after screw removal (3/30 cases)
Krukreti et al. [15]	2005	36	Open reduction (3.5 mm screw) 17 screw through syndesmosis (4 tricortical) 19 screw above syndesmosis (3 tricortical)	35.4	No outcome scores: above syndesmosis: 16 satisfied; through syndesmosis: 15 satisfied No significant differences in terms of range of motion No outcome scores	No failures
Moore et al. [16]	2006	127	Open reduction (3.5 mm screw) 59 tricortical screw 61 quadricortical screw	5	OMAS 83	Tricortical screw: 5 broken, 3 loss of reduction Quadricortical screw: 4 broken
Karapinar et al. [17]	2007	46	22 tricortical screw 24 quadricortical screw	12	OMAS 83	Quadricortical screw: 3 complete synostosis, 8 incomplete Tricortical screw: 2 incomplete synostosis
Hamid et al. [18]	2009	52	Open reduction + 3.5 mm screw (45 tricortical, 7 quadricortical)	30	27 screw removed: AOFAS 85.8 10 broken screw: AOFAS 82.4 15 intact screw: AOFAS 83.7 No significant difference No outcome scores	No correlation between broken screws and number of cortices
Hsu et al. [19]	2010	52	Closed reduction + 3.5 mm screw Group 1: screw removed after 6 weeks Group 2: screw removed after 3 months Group 3: screw removed after 9 months	19	27 screw removed: AOFAS 85.8 10 broken screw: AOFAS 82.4 15 intact screw: AOFAS 83.7 No significant difference No outcome scores	Secondary diastasis: Group 1 (3/19), Group 2 (3/20), Group 3 (0) Broken screw: Group 2 (3), Group 3 (2) No significant difference between "broken screw" and "secondary diastasis"
Schepers et al. [20]	2011	76	17 double screw fixation 59 single screw fixation (60 tricortical, 16 quadricortical)	NC	No outcome scores 7 superficial infections 2 deep infections	5 diastasis 5 broken screw before removal
Sagi et al. [21]	2012	68	3.5 mm screw 55 closed reduction 13 open reduction	24	27 poor reduction (15% open, 44% closed) Open reduction leads to better clinical outcomes Good reduction: OMAS 72.7 Poor reduction: OMAS 46.3 No outcome scores	No failures
Franke [22]	2012	251	3.5 mm tricortical screw (195 single screw, 56 double screw)	NC	No outcome scores	82 poor reduction
Tucker et al. [5]	2013	63	Open reduction + syndesmosis screw	31	43 screw removed: OMAS 75 20 screw left in place: OMAS 81.5 No outcome scores	No failures
Mendelsohn et al. [23]	2013	212	Closed reduction and then "open repair" if failure 102 obese (87% 3.5 mm screw, 63% single screw, 67% quadricortical) 110 non-obese (95% 3.5 mm screw, 62% single screw, 72% quadricortical)	3	No outcome scores	Obese: 15 loss of reduction Non-obese: 2 loss of reduction
Boyle et al. [24]	2014	51	Open reduction + 4 mm quadricortical screw	12	Screw removed: OMAS 86.7/AOFAS 90.1 Screw not removed: OMAS 82.4/AOFAS 88.6 No significant difference OMAS and AOFAS: 93	Without removal: 1 case of diastasis 4 months after screw broke
Our study	2016	126	Open reduction + 3.5 mm screw (87 tricortical and 39 quadricortical)	70.8	OMAS and AOFAS: 93	7 diastasis

NA: not available.

It is generally accepted that this screw must be removed 6 to 8 weeks after surgery before weight bearing is allowed; however, there is no evidence that this approach is better [18,24,5]. Leaving the screw in place leads to breakage in up to 13% of cases [28], but this does not appear to negatively impact the outcomes [18]. There was a 4% rate of screw breakage in our study, evidence of inadequate patient compliance in some cases or an inability to unload

the operated leg while walking. Obesity is a known risk factor for the screw breaking [23]. But screw removal also has an element of risk. Schepers et al. [20] reported a 22.4% complication rate after screw removal, including a 9.2% infection rate and a 6.6% rate of loss of reduction with reappearance of the diastasis. Our study had similar findings: 4% infection rate, 5.6% secondary diastasis rate. Removing the screw before 6 weeks post-surgery reduces the screw

breakage rate but also increases the rate of diastasis recurrence [19].

High quality syndesmosis reduction affects the prognosis and functional outcomes, and helps to prevent secondary osteoarthritis [14]. Any clinical repercussions of poor reduction occur quickly, within 2 years of the surgery [21]. Inadequate reduction appears to be fairly common: about 25% to 52% of cases [14,19,21,29]. We had two cases of poor initial reduction in our study but this had no effect on the clinical or radiological outcomes after a mean follow-up of 5 years. A direct approach to the DTFJ is recommended by some authors because the ability to visually control the reduction reduces the malreduction rate from 50% to 15% [21,29,30]. We have not used isolated percutaneous screw fixation in these situations. We do not believe that perfect reduction can be achieved, and this can pave the way for secondary deformity. We do not support this practice.

Two-dimensional intraoperative controls with fluoroscopy are required but may be insufficient, leading some authors to recommend three-dimensional intraoperative imaging [22,31,32]. It is important that incorrect reduction be detected and quantified; if there is any doubt, a CT scan should be performed. However, it is difficult to make a broad recommendations for surgical revision techniques because of significant anatomical variations among individuals [33]. Conversely, although there are variations between individuals, the variation between the size of an individual's two ankles is small, averaging 2.3 mm [34]. Some authors propose carrying out systematic imaging of the contralateral side [35]. It is important to point out that the flawed reduction can be retained by the syndesmosis screw. Song et al. [36] analysed the effect of screw removal on the alignment of the DTFJ. Twenty-five patients were evaluated prospectively. A postoperative CT scan revealed nine instances of poor reduction. One month after the screw was removed and the patients had started walking again, eight (89%) of these nine defects had spontaneously reduced, underlining this joint's ability to recover.

In summary, treatment by temporary screw fixation and ligament repair leads to good objective outcomes, confirming our hypothesis. However, there is little published data and no consensus on the fixation method or the need to remove the screw.

## Disclosure of interest

F.B.: educational consultant for Amplitude® and Serf®.

P.A.: educational consultant for DePuy-Synthes®.

M.E.: educational consultant for DePuy-Synthes® and Lépine®.

The authors S.S., B.P., D.B., N.M. declare that they have no competing interest.

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