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ORIGINAL PAPER

Surgical treatment of syndesmotic diastasis: emphasis on effect of syndesmotic screw on ankle function

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Abstract Fifty-two consecutive adult patients with syndesmotic diastasis (SD) were treated with closed anatomical reduction and stable fixation by a trans-syndesmotic cancellous screw. A short leg splint was prescribed for a six week postoperative period. Treatment outcomes of syndesmotic screw removal at various time points were studied and compared (group 1 at six weeks, group 2 at three months and group 3 at an average of nine months). Recurrence of SD, incidence of syndesmotic screw breakage and ankle function were compared among the three groups. Recurrence of SD occurred in 15.8% (3/19) of patients in group 1, 15.0% (3/20) in group 2 and 0% (0/13) in group 3 (p=0.054). Breakage of the syndesmotic screw occurred in three patients within three months (group 2, 15.0%) and in two patients beyond three months (group 3, each at six and 12 months, 15.4%). None of the group 1 patients experienced screw breakage (p=0.034). Forty-three patients (82.7%) were classified as having satisfactory outcomes. Ankle function did not significantly differ among the three groups (p=0.191), with or without syndesmotic screw breakage (p=0.343) and with or without SD recurrence (p=0.218). In conclusion, restriction of daily activity for at least three months is required to prevent recurrence. Removal of the syndesmotic screw at six weeks may prevent its breakage but increases the risk of recurrence. Over an average follow-up of 19 months, SD recurrence does not lead to deterioration in ankle function.

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Introduction

Syndesmotic diastasis (SD) is uncommon and normally caused by high-energy injuries [14, 15, 20, 25]. Clinically, isolated SD is rare and often associated with uni- or bimalleolar fractures. Because normal ankle function is dependent on the integrity of the ankle joint, an unreduced syndesmosis cannot achieve a satisfactory outcome [9]. Therefore, once SD occurs, surgical treatment with anatomical reduction and stable fixation of the syndesmosis is the gold standard method of treatment [14, 15, 20, 25]. In practice, the syndesmosis is stabilised by one or two trans-syndesmotic cancellous screws.

Previous studies have recommended the removal of the syndesmotic screw before resuming normal daily activity to avoid the risk of trans-syndesmotic screw breakage [14, 15, 17, 20, 25]. If the screw breaks, it is very difficult to remove [16]. Because removal of the syndesmotic screw requires a surgical procedure, it presents some degree of inconvenience for both surgeons and patients. Removal of the syndesmotic screw is occasionally neglected either by surgeons or by patients. The optimal time for screw removal, incidence of screw breakage and ankle function after screw breakage have not been consistently reported [5, 14, 15, 20, 25]. This retrospective study aimed to report the experience of a surgical team in treatment of SD and to identify a therapeutic recommendation.

Materials and methods

From June 2003 to June 2007, 56 consecutive adult patients (>16 years) with SD were surgically treated at our institution. Four patients were lost to follow-up postoperatively and were excluded from this study. The remaining

52 patients included 42 male and ten female patients aged from 23 to 82 years (average 61 years). Causes of injury included fall on uneven ground (31 patients), traffic accidents (15 patients) and fall from heights (six patients). The associated ankle fractures included 22 bimalleolar fractures, 15 lateral malleolar fractures and eight medial malleolar fractures. Seven patients sustained isolated SD, and there were no trimalleolar fractures. Inclusion criteria for this study were diagnosis of SD and regular patient follow-up for at least one year. Exclusion criteria were no regular follow-up for more than one year or SD associated with pilon fractures (fractures involving the tibial plafond) [2].

In the emergency department, the general condition of the patients was carefully controlled and SD was treated as early as possible. If local ankle swelling was marked, a short leg splint was temporarily applied. Patients were admitted and the injured ankle was elevated until subsidence of swelling [2]. The diagnosis of SD was based solely on anteroposterior and lateral radiographs of the ankle. No physical tests were conducted because of severe local tenderness and swelling [22–24].

Surgical technique

Patients were given spinal anaesthesia and placed on the operating table in the supine position. A pneumatic tourniquet was routinely used.

The lateral malleolar fracture was first openly reduced and stabilised with a semi-tubular plate (Synthes, Bettlach, Switzerland) [12, 21]. The medial malleolar fracture was then openly reduced, and a cancellous screw (Synthes, Bettlach, Switzerland) was inserted. With mediolateral manipulation, the stability of the syndesmosis was routinely checked [22–24]. If the stability was insufficient, one cortical screw of the semi-tubular plate, 2–3 cm proximal to the tibial plafond, was replaced by a 3.5-mm cancellous screw (Synthes, Bettlach, Switzerland). If there was no fracture of the lateral malleolus, a 3.5-mm cancellous screw was simply inserted from the fibula. The length of this screw was chosen such that it passed through the syndesmosis but did not pass through the medial tibial cortex (i.e. three-cortex fixation only) [15, 25]. The location of screws and reduction of the syndesmosis were confirmed by an image intensifier. After the wound was closed with absorbable sutures, a short leg splint was applied.

After surgery, patients were allowed to walk with protected weight-bearing as early as possible. A full range of motion of the knee and toes was encouraged. Patients were followed up at the outpatient department at six weeks, three months, one year and whenever necessary. The short leg splint was removed at six weeks and patients were advised to walk without aids. Exercise was permitted only after removal of the syndesmotic screw. The time of removal of the syndesmotic screw was decided by the individual surgeon. Removal of implants for ankle fractures was advised after one year.

Removal of the syndesmotic screw was normally performed under local anaesthesia. Under the guidance of an image intensifier, the screw was withdrawn with a screwdriver.

To compare outcomes in patients with syndesmotic screw removal at different time points, patients were divided into three groups: group 1, syndesmotic screw removal at six weeks; group 2, screw removal or breakage at three months; and group 3, screw removal or breakage beyond four months. Ankle function was evaluated with Bray's scoring system (Table 1) and four grades were assigned [3]. This scoring system evaluated pain, work, walking, sports, aids, range of motion and swelling. A satisfactory outcome consisted of an excellent or good grade.

Recurrence of SD was defined as further widening of the syndesmosis by more than 2 mm from the status before

Table 1 Bray's scoring system for evaluation of ankle function

Variable	Score
Pain	
After heavy activity	10
After mild activity	20
Mild constant pain	30
Severe constant pain	50
Function	
Work	
Change in pre-injury level of employment	5
Walking	
Unlimited	0
More than 10 blocks	5
Less than 10 blocks	10
Sports	
Unlimited	0
Limited	5
Aids	
Cane or crutch	5
Walker	10
Range of motion, compared to normal side	
Better than 75%	0
25–75%	5
Less than 25%	10
Swelling	
None	0
Less than 2.54 cm	5
More than 2.54 cm	10

Total subtracted from 100 points: 90–100 = excellent, 75–89 = good, 50–74 = fair, less than 50 = poor

removal of the syndesmotic screw, as determined by the anteroposterior view of an ankle radiograph. The choice of 2 mm corresponded to the upper limit of acceptable value of step-off in intra-articular fractures [1, 5, 8, 19].

For comparison, Fisher's exact test was used. A p value of<0.05 was considered statistically significant.

Results

The cohort of 52 patients was regularly followed up for an average of 19 months (range 12–36 months). All ankle fractures were healed with a union rate of 100% (Fig. 1). There were no cases with deep wound infection.

Nineteen patients (group 1) had syndesmotic screw removal at six weeks soon after the use of the short leg splint was discontinued. Twenty patients (group 2) had syndesmotic screw removal or screw breakage around three months. The remaining 13 patients (group 3) had syndesmotic screw removal or screw breakage at an average of nine months (range 5–16 months).

Recurrence of SD occurred in 15.8% (3/19) of group 1, 15.0% (3/20) of group 2 and 0% (0/13) of group 3 (Table 2, Fig. 2). Recurrence rates among the three groups were not statistically significant ($p=0.054$). Additionally, if groups 1 and 2 were combined and compared with group 3, there was no statistically significant difference ($p=0.160$). The widening increased with an average of 3.8 mm (range 3–7 mm).

Breakage of the syndesmotic screw occurred in three patients within three months (group 2, 15.0%, Fig. 3) and in two patients beyond three months (group 3, each at six and 12 months, 15.4%). None of the group 1 patients experienced a screw break. The rate of screw breakage among the three groups was statistically significant ($p=0.034$, Table 2), although there was no statistically significant difference between groups 1 and 2 ($p=0.125$) or between groups 1 and 3 ($p=0.157$). Groups 2 and 3 showed no statistically significant difference in the rate of screw breakage ($p=0.375$). Additionally, if groups 2 and 3 were combined and compared to group 1, there was no statistically significant difference ($p=0.091$). The broken syndesmotic screw was left in situ and no removal was planned [14].

Ankle function was evaluated, and 43 patients (82.7%) were classified as having satisfactory outcomes [3]. The remaining nine patients had unsatisfactory outcomes, which were noted in four of 22 (18.2%) patients with associated bimalleolar fractures, three of 15 (20.0%) with lateral malleolar fractures, one of eight (12.5%) with medial malleolar fractures and one of seven (14.3%) with isolated SD. A comparison of ankle function among the four groups revealed no statistical differences ($p=0.051$). The comparison between SD with or without associated ankle fractures was not statistically different ($p=0.410$). Ankle function among the three groups with various intervals of syndesmotic screw removal showed no statistically significant difference ($p=0.191$, Table 2). Ankle function between patients with or without syndesmotic screw breakage was not statistically different ($p=0.343$). Patients with and without SD recurrence showed no significant difference in ankle function ($p=0.218$).

Fig. 1 A 34-year-old woman sustained a right bimalleolar fracture with syndesmotic diastasis in a motorcycle accident. All injuries were treated by internal fixation. The syndesmotic screw, together with all implants, was removed at 14 months. No implants failed and ankle function was excellent

Table 2 Comparison of clinical outcomes among three groups with various intervals of removal of syndesmotic screws (n=52)

Item	Group 1 (n=19)	Group 2 (n=20)	Group 3 (n=13)	p value
Recurrence of syndesmotic diastasis	15.8% (3/19)	15.0% (3/20)	0% (0/13)	0.054
Breakage of syndesmotic screw	0% (0/19)	15.0% (3/20)	15.4% (2/13)	0.034*
Satisfactory ankle function	84.2% (16/19)	80.0% (16/20)	84.6% (11/13)	0.191

*Statistical difference

Discussion

The syndesmosis connecting the distal tibial and fibular bony structures normally sustains large three-dimensional loads in daily activity [4–6, 9, 11]. Ankle stability depends greatly on the intact ankle mortise. Once SD occurs, the ankle immediately loses mediolateral restriction provided by the bony contour. Therefore, patients immediately lose walking ability. An ankle with non-anatomically reduced syndesmosis may progress to osteoarthritis and cause lifelong disability [14, 15, 20, 23, 25]. Closed anatomical reduction and stable fixation to prevent recurrence are reported to be the gold standard of treatment [14, 15, 20, 23, 25]. Because a definitive, reliably successful procedure has not been established, this study attempts to establish a reasonable principle to resolve this controversial issue.

In this series of patients, we studied whether SD recurrence greatly affects ankle function. Of 52 patients, six (11.5%) sustained this complication. There was no significant difference in ankle function in patients with and without SD recurrence (p=0.218). The widening increased at an average of 3.8 mm (range 3–7 mm). An unreduced SD has been reported to compromise ankle function [10, 26]. The acceptable SD was 3–4 mm [23]. Although in biomechanical terms, the lateral malleolus only sustains one sixth of ankle loads in the stance phase of a gait cycle, a long-term follow-up may be necessary to evaluate longitudinal outcomes [6, 9, 11].

In cases of syndesmotic screw breakage, we studied the effect of leaving the broken screw end in situ. Of 52 patients, 5 (9.6%) sustained this complication. Ankle function between patients with or without syndesmotic screw breakage was not statistically different (p=0.343). Ankle function in patients with a broken or removed syndesmotic screw is reported to be better than in those with an intact syndesmotic screw [13, 18]. In biomechanical terms, the syndesmosis is immobilised by an intact syndesmotic screw and leads to inferior ankle function. However, in our study, a 3.5-mm cancellous screw may not cause rigid immobilisation and therefore does not significantly inhibit ankle function.

No significant differences were observed in ankle function among the three groups with various intervals of syndesmotic screw removal (p=0.191). Ankle function with an intact syndesmotic screw was reported to be inferior to that with screw removal [13, 18]. In our study,

Fig. 2 A 38-year-old man sustained a left lateral malleolar fracture with syndesmotic diastasis in a fall while running. Both injuries were treated by internal fixation. The syndesmotic screw was removed at 3 months, but there was recurrence of syndesmotic diastasis

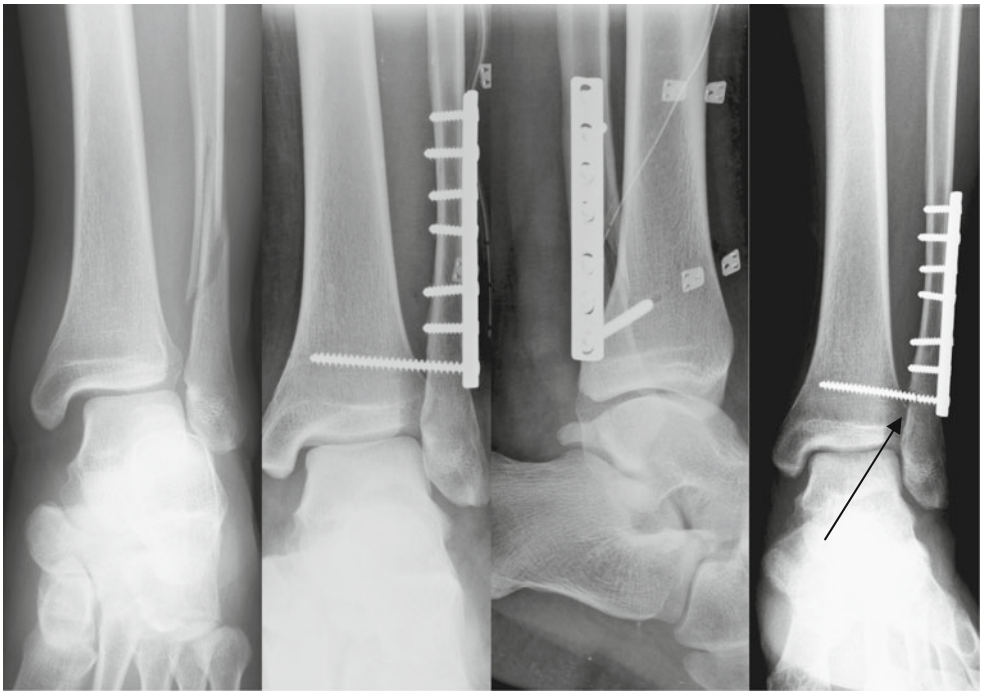

Fig. 3 A 28-year-old man sustained a left lateral malleolar fracture with syndesmotic diastasis when he fell from a ladder. Both injuries were treated by internal fixation. At 3 months, the syndesmotic screw was found to be broken (*arrow*), but the patient had no symptoms

stable immobilisation of the syndesmosis was achieved using a single 3.5-mm cancellous screw. Thus, using a 4.5-mm cancellous screw or double 3.5-mm cancellous screws to stabilise the syndesmosis may be unnecessary.

The effects of associated ankle fractures on ankle function were studied. Forty-five patients had associated ankle fractures, and only seven patients sustained isolated SD. Unsatisfactory ankle function was noted in eight of 45 patients (17.8%) with associated ankle fractures and one of seven patients (14.7%) with isolated SD. However, these results were not statistically significant (p=0.410). Associated ankle fractures were reported to have significant effects on the outcome of ankle function [7]. Because ankle fractures may generally be treated successfully using current surgical techniques, associated ankle fractures should not affect ankle function in patients with SD.

The syndesmotic screw may break after resuming normal daily activity. Screw breakage occurred between six weeks and three months in 15% of patients and after three months in 15.4% of patients. There were no cases of screw breakage at six weeks when normal daily activity did not begin (Table 2). The syndesmotic screw was recommended to be removed at three months [15, 25]. In our series, 15.8% of patients experienced SD recurrence at six weeks and SD recurred in 15.0% of patients in whom the screw was removed between six weeks and three months. There were no cases of SD recurrence after five months. In theory, the ideal long-term outcome after surgical treatment of SD should be perfect reduction of the syndesmosis [5]. Thus, to prevent breakage of the syndesmotic screw and to avoid SD recurrence, the optimal time to remove the syndesmotic screw may be at least three months. After the short leg splint is discontinued and daily activity resumes, exercise restriction prior to removal of the syndesmotic screw may reduce the risk of screw breakage and avoid SD recurrence. In our study, screw removal was completed under local anaesthesia with minimal risk.

In earlier studies, four-cortex fixation of the syndesmotic screw has been advocated to have several advantages: more stable immobilisation of the syndesmosis and convenient removal of the end of a medially located, broken syndesmotic screw [15, 25]. However, the most recently published biomechanical comparisons showed no difference between three- or four-cortical fixation [5, 19]. Moreover, overly rigid immobilisation of the syndesmosis by four-cortical fixation had an adverse effect on ankle function [13, 18, 23]. In our study, we used one 3.5-mm cancellous screw with tricortical fixation to treat SD and achieved a satisfactory outcome rate of 82.7%.

The limitations of this study include its small sample size, which was insufficiently powered to identify statistically significant differences. Consequently, the inferences of our study may not be definitive. The SD recurrence rates among the three groups were not statistically significant (p=0.054). If the sample size were larger, we might find that group 3 had the lowest risk of SD recurrence. Associated ankle fractures did not affect ankle function in this study (p=0.051). Similarly, if the sample size were larger, a totally different conclusion might be reached. Further studies with larger sample sizes are essential to confirm the reliability and validity of the results presented here.

In conclusion, closed anatomical reduction and stable fixation with a trans-syndesmotic cancellous screw may be a highly successful method for the treatment of SD. Restriction of daily activity for at least three months is required to prevent recurrence. Removal of the syndesmotic screw at six weeks may prevent its breakage but increases the risk of recurrence. Over an average follow-up of 19 months, SD recurrence does not lead to deterioration in ankle function.

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