Klinik Çalışma

A COMPARISON OF THE ANK NAIL TO CONVENTIONAL FIXATION TECHNIQUES IN WEBER B AND C ANKLE FRACTURES

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Summary

Background: The aim of this study was to determine the functional and radiographic outcome of Weber B and C ankle fractures with syndesmotic injury and compare the syndesmotic screw and the ANK nail.

Material and Methods: Of thirty-one patients with syndesmosis injury, sixteen were treated with open reduction and internal fixation with an ANK nail, and fifteen patients with a plate and supplemental syndesmotic screw. A clinical, anatomical and arthritis grading ankle scoring system according to Phillips was used to study the outcomes of each group.

Results: There was no statistically significant difference between the two groups with respect to clinical score and anatomical score ($p>0.05$) but in the mean arthritis grading scoring ($p<0.005$). The most frequent complication (four patients from the ANK group, two patients, in the plate and screw group) was fibular shortening.

Conclusion: We conclude that syndesmotic screw might put some biomechanical stresses on the ankle joint. And also, if the fibular fracture is oblique and comminuted, which represents most of the ankle fractures, the ANK nail, which cannot prevent fibular shortening, does not seem an alternative technique to the syndesmotic screw and plate fixation in the ankle fractures with syndesmosis rupture.

Keywords: Ankle fracture, syndesmotic screw, fibula

Weber B ve C Ayak Bileği Kırıklarında ANK Çivisinin Mevcut Tespit Yöntemleri ile Karşılaştırılması

Özet

Giriş: Bu çalışmanın amacı sidesmoz yaralanması olan Weber B ve C ayak bileği kırıklarının işlevsel ve radyolojik sonuçlarını ortaya koymak ve sindesmoz vidası ile ANK çivisini karşılaştırmaktır.

Hastalar ve yöntem: Sindesmoz yaralanması olan 31 hastanın 16 tanesine açık redüksiyon ve ANK çivisi ile tespit yapılırken, 15 tanesine plak ile tespit yapıldı ve sindesmoz vidası kullanıldı. Her bir grubun klinik, anatomik ve artritik değerlendirilmesi Philips'in ayak bileği değerlendirme kriterlerine göre yapıldı.

Sonuçlar: İki grup arasında klinik ve anatomik skor açısından fark yok iken ($p>0.05$),

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ortalama artritik skor açısından fark mevcuttu ($p<0.005$). En sık komplikasyon (ANK grubunda dört hasta, plak-vida grubunda iki hasta) fibular kısalık idi.

Çıkarımlar: Sonuç olarak sindesmoz vidası ayak bileğindeki biyomekanik stresi arttırabilir. Fibular kısalmayı önleyemeyen ANK çivisi, ayak bileği kırıklarının büyük bir çoğunluğunu oluşturan oblik ya da parçalı fibula kırıklarında, plak-vida uygulamasına alternatif bir tedavi yöntemi gibi durmamaktadır.

Anahtar kelimeler: Ayak bileği kırık, sindesmoz vidası, fibula

Introduction

Weber B and C type fractures might be associated with a partial or complete rupture of the syndesmosis. Syndesmotic screw is the most frequent method to fix syndesmosis injury but controversy still exists concerning the radiographic criteria for syndesmotic fixation[1-4]. Ebraheim et al stated that the level of the fibular fracture is insufficient for the evaluation of syndesmosis and that the depth of incisura fibularis, posterior malleolus fractures, deltoid ligament injury and subluxation of the fibula should also taken into consideration[5]. There is general agreement that syndesmotic fixation is required if there is significant instability of the syndesmosis after fixation of the medial and lateral malleoli or if injury occurs greater than 5 cm above the ankle joint[2,5,6].

Most commonly, screws are used to fix the syndesmosis. The syndesmotic screws are mostly placed through both cortices of the fibula and one cortex of the tibia after achieving anatomic reduction and fixation of the fibula with a plate. The syndesmosis screw is effective in holding the joint which has been anatomically reduced and allows ligamentous healing, but the issue of the removal of the syndesmotic screw is still controversial. Some authors recommend removal of the syndesmosis screw at 6 to 12 weeks, before weight bearing is allowed[7]. However, Finsen et al detected no adverse effects because of patients having walked before the syndesmosis screw had been removed[8]. Weight bearing with the screw in place can lead to screw breakage and the procedure itself is not without complications. For example, if the syndesmotic screw is put too high, it may cause angulation of the fibula, if it is too low, it may cause calcification, if it is too tight, it may restrict dorsiflexion[9]. The ANK nail was proposed an alternative to the syndesmotic screw and fibular plate fixation[10] (Fig 1). This device was designed to stabilize the fibula fracture and hold the syndesmosis reduced, while allowing more physiologic motion of the fibula than is possible with syndesmotic screw fixation.

In this retrospective case-comparative study, we compared two similar groups of patients with Danis-Weber B or C fracture diastasis, who were treated with either a syndesmotic screw as an adjunct to internal fixation by plate or an ANK nail. Two previous reports on the ANK nail were favorable but neither were comparative studies[10,11]. The purpose of this study was to examine the results of fibular plating with supplemental syndesmotic screw versus the ANK nail in ankle fractures with syndesmosis injury.

Material and Methods

Ninety-six consecutive patients with ankle fractures treated surgically between December 1996 and December 2000 in our hospital were identified. In this retrospective study, Fifty-eight cases (25 cases Weber type A, 29 cases Weber type B, four cases Weber type C fracture) were excluded from the study because they did not have a syndesmosis injury and fixation. Of seven patients who lost follow-up, five were Weber type B, two, Weber type C. Thirty-one of the remaining thirty-eight patients, who had been followed-up for at least 18 months, were included in this study. All fractures in this study were displaced with syndesmosis injury and classified as type B and C according to the Danis-Weber classification. Twenty-four patients had additional medial malleolus fractures and the remaining seven patients, complete deltoid ligament rupture. Fifteen patients were male and sixteen female. The average age of the patients was 44 years (range, seventeen to seventy-six years). Of the thirty-one patients with syndesmosis injury, sixteen were treated with open reduction and internal

Table 1. Type of the fracture and implants used

	ANK nail	Plate and syndesmotic screw	Total
Type B	11	8	19
Type C	5	7	12
Total	16	15	31

Table 2. Results according to Phillips' criteria

	Subjective score	**Objective score**	**Anatomic score**	**Arthritic score**
ANK	69.06	17.13	30.40	3.18
Conventional	60.91	15.18	27.50	7.81

fixation with an ANK nail, and fifteen patients with plate and supplemental syndesmotic screw (Table 1). The determination of syndesmotic injury was based upon preoperative AP or mortise radiographs as well as intraoperative stress testing after bone stability had been achieved. The surgical method was chosen according to the surgeon's preference except with comminuted fractures (three cases), in which case plate and screw were always used. Because of the limited axial stability of the ANK nail, plate and screw were preferred for comminuted fractures. There were no significant differences in the distributions of age, sex or fracture type according to the Weber classification in the two treatment groups ($p>0.05$). The mean time of follow-up was 34.6 (34 months in the ANK group and 36 months in the plate-screw group) months (range 18 to 53 months).

Surgical technique

Of the twenty-four patients with additional medial malleolus fractures, sixteen were first fixed with malleolar screws and eight with tension band techniques. This decision was unrelated to the technique chosen for lateral malleolus. If the deltoid ligament was ruptured completely, repair of the ligament was done after osteosynthesis of lateral malleolus. There were two reasons for this; one was not to put stress on the repaired ligament and the other, to be sure of tendon interposition in the medial joint space. Either an ANK nail or a plate and screw with syndesmotic screw were used to fix lateral malleolus except in comminuted fractures (three cases) for which plate and screw fixation was always preferred. Of the thirty-one patients, sixteen were treated with open reduction and internal fixation with an ANK nail, and fifteen patients with a plate and supplemental syndesmotic screw. All of the patients were operated on during the

Figure 1. The ANK nail.

first 24 hours by five senior surgeons using whichever technique they preferred except comminuted fractures.

For those patients in whom a syndesmotic screw was used, osteosynthesis of the fibula was first performed with a 3.5 mm plate posterolaterally. After fibular osteosynthesis, the syndesmosis was examined by applying an anterolateral traction force to the fibula to see if there was significant movement and widening (more than 2 mm) between the tibia and fibula. In the cases with syndesmosis injury a 3.5 mm cortical screw was applied through both cortices of the fibula and one cortex of the tibia with the ankle in the position of 20 degrees of dorsiflexion. A below-knee posterior splint was applied to the ankle and worn for 3-4 weeks. Partial weight bearing was allowed in 6-8 weeks postoperatively after the syndesmotic screw was removed under local or regional anesthesia (Fig 2-3).

For those patients in whom an ANK nail was used, syndesmosis instability was assessed by both preoperative radiographs and traction test prior to nail insertion during surgery. In the cases with syndesmosis instability, the ruptured ligament was clearly seen during surgery in some cases and the traction test (more than 2 mm widening in the syndesmosis) was positive in all cases. To insert the ANK nail, a hole was opened 5 mm proximal to the tip of the lateral malleolus on the lateral site. While anatomic reduction was being maintained with a bone-holding clamp, the ANK nail was inserted until its curved end reached the distal end of the fibula. The hole of the ANK nail was then brought against the anterolateral part of the tibia. While holding the ankle in neutral position, a 4.5 mm ASIF cancellous screw was applied to the tibia through the hole of the ANK nail to fix it, by holding the ankle in a neutral position (Fig 4-5). In cases of long oblique fibula fractures, intramedullary fixation alone was not enough to maintain reduction. In five cases, when fractured ends were released from the bone-holding clamp after fixation with the ANK nail, the fracture line did not maintain anatomic reduction. Then a cerclage wire was applied to hold the proximal and distal fragments together in addition to the ANK nail. This was done to prevent rotation of the distal fragment and provide length restoration of the fibula. A posterior splint was applied postoperatively for 2-3 weeks and at that time a range of motion exercises was begun. While dorsiflexion of the ankle beyond the neutral was not allowed in the patients with plate and screw, full ROM was encouraged in the ANK group. Approximately six weeks

Figure 2. AP (a) and

Figure 2. Lateral (b) radiographs of bimalleolar fractures of the ankle (type C, according to Danis-Weber)

after the index operation partial weight bearing was allowed in the ANK group. In the plate and screw group, weight bearing was allowed 6-8 weeks after the index surgery when syndesmotic screw was removed.

At the follow-up examination, AP, lateral, mortise views and stress radiographs were obtained. A clinical, anatomical and arthritis grading ankle scoring system according to Phillips was used to study the results[12]. The clinical score (maximum 100 points) includes evaluation of pain and function which constitute subjective criteria (80 points), and gait, ROM which constitute objective criteria (20 points), in the ankle and subtalar joints. The anatomical score (maximum 35 points) consider radiographic measurements. In the arthritic score (maximum 15 points), two categories of long-term radiographic changes were examined: degenerative changes (i.e. osteophytes, joint-space narrowing, periarticular cysts) and abnormalities (i.e. non-union, distal tibiofibular synostosis, osteoporosis, joint surface irregularities). Arthritic score obtained was subtracted from the maximum score. These three scores were combined to give a total score of 150, which is a perfect result[12]. One of us (H.F.K) performed the clinical (subjective and objective) anatomical and arthritic score evaluation of patients and arthritic and anatomical scoring were performed by the second author (H.B) separately. Both values and also the mean of the two values of the individual authors were used in the statistical analysis. The mean of each score for each group was calculated and compared by the unpaired t-test. Fibular shortening was determined by measuring the talocrural angle (the distance between the line tangential to the distal joint surface

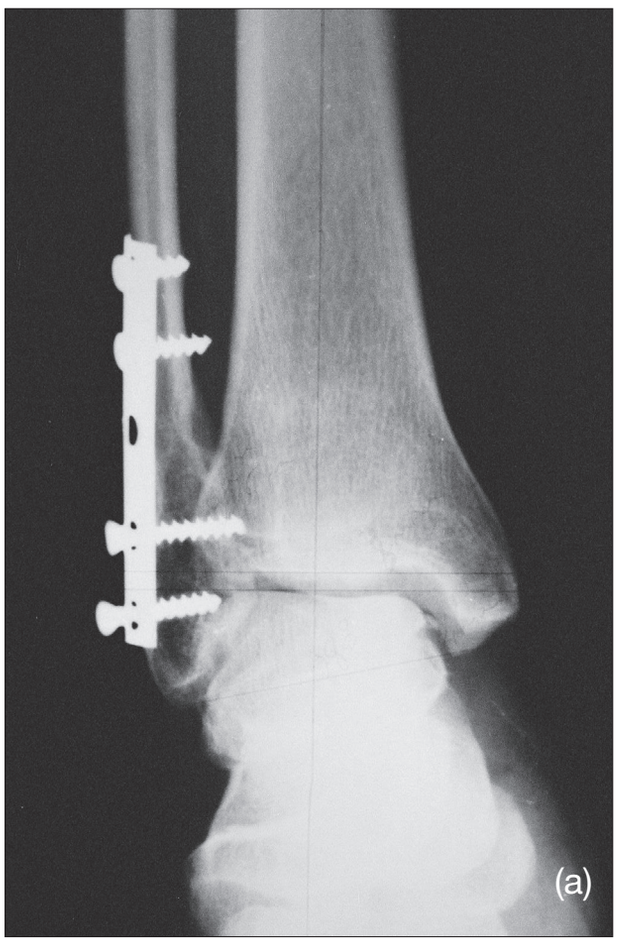

Figure 3. Post-operative AP (a) and

Figure 3. Post-operative lateral (b) radiographs of the patient after 45 months. Internal fixation with plate and screw was used for lateral malleolus. The ruptured deltoid ligament was repaired. A supplemental syndesmotic screw was inserted and removed later on, of which the empty hole

of the tibia and the lower tip of the fibula) on both injured and uninjured ankles. Fibular shortening was evaluated immediately post-operatively and at the last follow up visit and compared Fisher exact test. Mean surgical times were calculated for each one of these two procedures and compared statistically.

Results

Thirty-one patients with Weber B and C fractures were included in this study. Sixteen of them were treated with an ANK nail, fifteen with plate and syndesmotic screw (Table 1). The follow-up period was 34 (range; 18-53) months in ANK and 36 (range; 18-52) months in plate and screw group. The difference was not significant ($p>0.05$). Fifteen patients had bimalleolar fractures, nine patients trimalleolar and seven patients lateral malleolar fractures with associated disruption of the deltoid ligament. None of the posterior malleolar extended beyond 30% of the articular surface of the ankle and consequently they were not internally fixed.

The results of the patients according to the Phillips' criteria were shown in Table 2. In the radiographic examination of the fifteen patients treated with plate and screw, one patient had a synostosis in the distal tibiofibular syndesmosis, seven patients had evidence of calcification in the syndesmosis; this was severe in two cases and minimal in the remaining five. Four patients had

Figure 4. AP (a) and

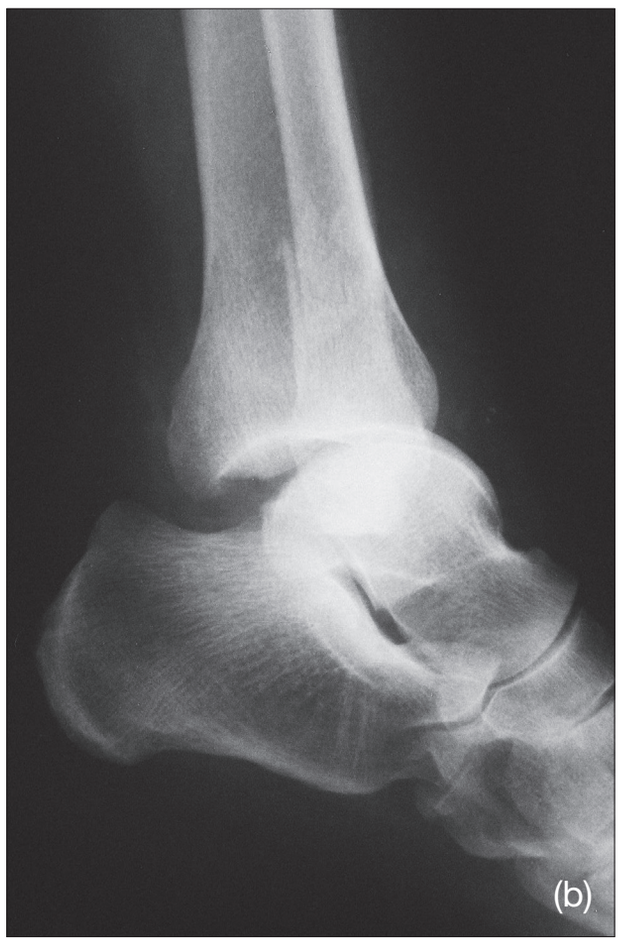

Figure 4. Lateral (b) radiographs of bimalleolar fractures of the ankle (Type C, according to Danis-Weber)

osteolysis around the placement of the syndesmotic screw. A more or less consistent finding in all cases using plate and screw was osteoporosis under the plate. No screws were broken. In the patients treated with ANK nail (16 patients) while there was no synostosis, two patients had minimal calcification in the syndesmosis, and three patients had osteolysis along the screw of the ANK nail. There was no widening of the syndesmosis in either group. There was no statistical difference between the two groups ($p>0.05$) except in the case of the arthritis score ($p<0.005$).

Mean postoperative immobilization time in the patients with the ANK nail was 2.7 weeks, the patients with plate and screw, 3.8 weeks. Mean partial weight bearing was 7.5 weeks, in the former group, 8.4 weeks in the latter. Differences were not significant between the two groups ($p>0.05$). The talo-crural angle was 79.73(78 to 82) in the former, 77.90(74 to 80) in the latter. The differences were not statistically significant ($p>0.05$). Although the surgical time was shorter in ANK (81 min±14.97) compared with the plate group (89 min±16.51), it was not significant statistically ($p>0.05$).

Two patients who had post-operative infections, one superficial and one deep, were from the group treated with plate and syndesmotic screw. Infections in both cases were treated successfully with parenteral antibiotics. Of the six patients with fibular

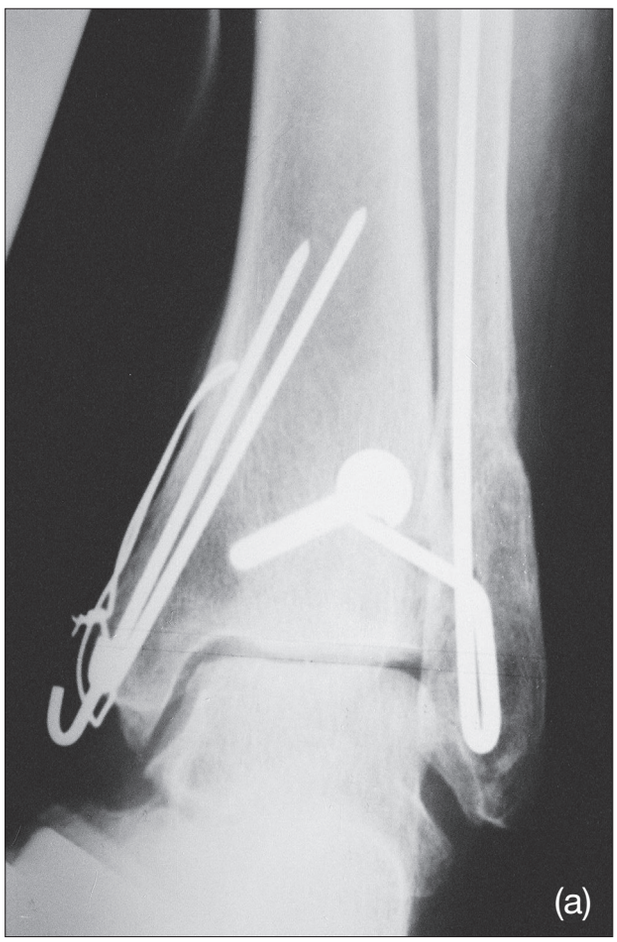

Figure 5. Post-operative AP (a) and

Figure 5. Post-operative lateral (b) radiographs of the patient. A tension band was applied for the medial malleolus. The ANK nail was used for latearal malleolus and syndesmosis. Oblique fracture without cerclage wire was healed with fibular shortening.

shortening (three with less than 2 mm, three between 2-4 mm), four were in patients with ANK nails (two less than 2 mm and two between 2-4 mm), two (one less than 2 mm and one between 2-4 mm) were in those with plate and syndesmotic screw. When we examined the cases with fibular shortening in the ANK group, three cases were without cerclage wire (Figure 5a). The remaining one patient had a long oblique fracture for which cerclage wire had been used in addition to the ANK nail. In the two cases which fibular shortening occurred in the plate and screw group, the fractures were comminuted. Shortening was evident on the early post-operative radiographs in both groups. Implants were removed from three patients in the ANK group on request of the patients but in none of the cases was it for symptomatic reasons. On the other hand, in the plate and screw group, most of the seven patients whose implant was removed, had symptoms of irritation or were disturbed by the implant being palpable.

Discussion

The syndesmotic ligament complex is the one of major ligaments resisting diastasis between distal tibia and fibula (4). With the Weber type B and C ankle fractures the syndesmosis is often disrupted. Not only is it difficult to detect syndesmosis disruption on the initial assessment on AP

and mortise radiographs, but the indications for fixations are under debate and some authors believe that syndesmotic fixation is overused[1-3,9,13-16]. The most commonly used technique to fix the syndesmosis ligament is the syndesmotic screw. Several problems have been reported with syndesmotic screw fixation[17-19]. The biomechanics of the ankle are complex. Motion in the saggital plane is coupled with axial and coronal plane motion. Dorsiflexion of the ankle causes posterolateral translation and external rotation of the the fibula[13,20,21]. Syndesmotic fixation prevents normal movements between the distal tibia and fibula and alters joint biomechanics[22]. Because of this, the motion of the ankle with a syndesmotic screw in place can cause additional trauma on the ankle and sometimes results in the fracture of the screw. Conversely, syndesmotic instability can result in persistent pain and progressive ankle arthritis. Therefore, elastic fixation of the syndesmosis, which allows fibular motion within physiologic limits, might be potentially advantageous.

One of the controversial topics is whether the syndesmotic screw should be removed before weight bearing is resumed. Proponents of leaving the screw in place point out that the screw loosens and allows patients to have near normal ankle motion[8,19,23]. Advocates of screw removal point out that leaving the screw in place results in abnormal ankle motion or at least screw breakage. Many others have recommended that weight bearing not be allowed until the screw supporting the syndesmosis has been removed[19,24,25]. After fixation of the unstable syndesmosis with a supplemental screw, non-weight bearing in a cast or a fracture brace for six to eight weeks is generally recommended[19,25]. However, the time needed for healing of the syndesmotic complex is unknown[9,19]. Removal of the screw involves some risk of redisplacement of the fibula if done at six weeks and earlier[26]. On the other hand, it was claimed that the ANK nail provides elastic fixation of the syndesmosis during weight bearing and allows flexion and extension movement in the ankle by not rigidly restricting the distal tibiofibular joint[10]. In addition, it was alleged that it allows internal or external rotation of the fibula within physiologic limits during the ankle motion[10]. Therefore, there might not need to remove the syndesmotic screw before weight bearing in the ANK nail and it is advantageous against rigid syndesmotic screw. We also allowed bearing weight with the ANK nail in this series and did not encounter any negative effect.

The values of mean subjective, objective and anatomical score were very close in the patients with the ANK nail and the group in which conventional fixation were used and, the differences were not statistically significant ($p>0.05$). However, the arthritic score was much higher in the plate and screw group and was statistically significant. Amendola stated that internal fixation with syndesmotic screw and plate results in abnormal biomechanical stresses on the ankle[26]. Kennedy et al found that the radiographic outcome score was poorer in those Weber C fractures treated with a syndesmotic screw in which the fibula fracture was within 5 centimeters of the joint[27]. Higher arthritic scores in the plate and screw group, in which syndosmosis fixed more rigidly compared to ANK group, support the findings of Amendola et al[26]. On the other hand, Rukavia reported that a shortened fibular malleolus was significantly associated with the development of osteoarthrosis[28]. When considered higher number of fibular shortening in the ANK group, higher arthritic score might be expected in the longer follow-up period in this group. These results appear to indicate that the ANK nail carries disadvantage of axial plan instability in lieu of advantage of frontal plan elasticity.

It is well known that after an intra-articular fracture, early motion may minimize damage to the articular cartilage by promoting cartilage nutrition and by preventing the formation of the intra-articular adhesions[29-31]. The exact healing time for the syndesmotic complex is unknown. Some authors recommend as much as 4 months duration for fixation of syndesmosis[3]. It is possible to start motion sooner after the operation with the ANK nail than with the plate and syndesmotic screw. Because, it is claimed that, the ANK nail might allow more physiologic movements of the lateral malleolus during the ROM of the ankle[10]. This may help prevent synostosis

and osteoporosis in the fibula which was a frequent finding in the patients with whom plate and screw were used.

Kara et al stated that in cases with comminuted fracture and oblique fractures shortness of the fibula was more often encountered[10]. To avoid this complication we preferred plate and screw fixation in comminuted fractures. We applied cerclage wire additionally in oblique fractures in which the ANK nail had not fixed the fracture line properly. In spite of this, we observed fibular shortening in four cases (1.5 to 4 mm) treated with the ANK and in two cases treated with the plate and screw (1.5 to 2.5 mm). When we reviewed these cases, we noticed that the reasons were insufficient anatomical reduction in both groups and in the patients with the ANK nail, oblique fracture line was another predisposing factor even when fixed with cerclage wires. We determined that it depended on implant insufficiency in the ANK group and imperfect reduction due to comminution of the fracture in the plate and screw group, because the same amount of shortness was evident on the early post-operative radiographs. We believe that anatomical reduction is the most important factor in either treatment method to avoid fibular shortness and also the ANK nail has some insufficiency to provide axial stability in the oblique fractures[28]. Two cases developed infection in the patients treated with the plate and syndesmotic screw. The increase incidence of infection in the plate and screw group may be explained by the wider exposure and the compromise of the periosteal blood supply with plate fixation.

Consequently, there are some limitations of using the ANK nail. In comminuted fractures the ANK nail does not provide enough stability therefore conventional methods should be chosen. In the oblique fractures, one and sometimes two cerclage wires may not be enough to assure stability. And also, the fibular blood supply can be damaged both by stripping (even if limited) of the periosteum and by the mechanical effect of cerclage wire, particularly if used in two levels. The other pitfall is a very narrow fibula. The medullary canale of the fibula must be checked to assure the appropriate diameter of the ANK nail. It can be troublesome inserting the intramedullary part of the ANK nail into a very narrow medullary canal.

We conclude that the ANK nail might provide elastic fixation of the syndosmosis in the early post-operative period in ankle fractures with syndesmosis rupture, however if the fibular fracture is oblique or comminuted, which represents the most common fracture types of ankle, it is not an alternative technique to the plate and syndesmotic screw fixation due to insufficiency of axial stability of the device. Additional one or two cerclage wire fixation with the ANK nail might be useful to increase stability in non-comminuted oblique fractures but, even it might not prevent fibular shortening.

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