Temporary Kirschner Wire Ankle Transfixation and Delayed ORIF

A Staged Operative Treatment for Closed Ankle Fractures with Tibiotalar Dislocations and Soft-Tissue Damage

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Abstract

Background and Purpose: Immediate ORIF (open reduction and internal fixation) is the treatment of choice for displaced ankle fractures. However, definitive treatment may have to be delayed due to compromised soft tissues. The value of temporary Kirschner wire ankle transfixation with staged ORIF for closed displaced ankle fractures with tibiotalar dislocations was determined.

Patients and Methods: In this retrospective case series (1997–2001), 92 patients (mean age 54 years, range 20–86 years) who underwent a staged procedure for isolated and closed displaced ankle fractures with tibiotalar dislocations were studied. Patients were primarily treated by means of immediate closed reduction. For stable fractures and adequate soft tissues a split plaster cast was applied (n = 50). K-wire transfixation was performed for unstable fracture-dislocations and/or critical soft tissues (n = 42). All patients underwent delayed ORIF after recovery of the soft tissues.

Results: In the K-wire group (KWG), local complication rate was 7%. Mean operating time was 30 min (5–65 min). In the plaster cast group (PCG), local complication rate was 10% ($p = 0.72$, not significant). Three redislocated ankles (6%) had to be transfixed secondarily. A higher grade of soft-tissue injuries in the KWG ($p < 0.05$) resulted in a longer time interval between primary treatment and staged ORIF (7 vs. 5 days; $p < 0.05$) and a longer hospital stay (19 vs. 17 days; $p < 0.05$) for the KWG.

Conclusion: Temporary K-wire ankle transfixation is an effective method for initial treatment of closed displaced ankle fractures with tibiotalar dislocation, if ORIF has to be delayed and immobilization in a split plaster cast is not suitable. Retention is reliable with a low complication rate.

Key Words
Temporary Kirschner wire ankle transfixation · Ankle fractures with tibiotalar dislocations · Delayed ORIF · Soft-tissue damage

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Introduction

Displaced ankle fractures with tibiotalar dislocation are a commonly seen orthopedic trauma. Immediate open reduction in combination with internal fixation (ORIF) according to the AO/ASIF guidelines [1] is the treatment of choice. However, in some situations primary ORIF is not suitable or even hazardous due to poor skin condition, severe swelling of soft tissues, or in multiply injured patients [2]. Prolonged dislocation and continued swelling in the region of the ankle are not well tolerated. Maintenance of reduction of unstable fractures and treatment of compromised soft tissue may be difficult in a split plaster cast [3]. For open fractures either immediate ORIF or a staged procedure using an external fixator followed by second looks and delayed ORIF are generally accepted treatment options. Decision making depends on the severity of the soft-tissue injury and other factors (e.g., general condition, relevant comorbidities, multiply injured patient).

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For closed ankle fractures with tibiotalar dislocations and soft-tissue damage, temporary Kirschner wire transfixation has been the treatment of choice in our unit for several years. We report our experience with a group of 42 patients treated with this method followed by delayed ORIF.

Patients and Methods

Between 1997 and 2001, a total of 326 ankle fractures were treated operatively in our unit. Twelve patients (4%) sustained open fractures and were treated with either immediate ORIF (six patients) or external fixation and delayed ORIF (six patients). 216 closed ankle fractures (66%) underwent immediate or delayed ORIF. Ankle fractures not operated on immediately due to soft-tissue swelling were immobilized in a split plaster cast and elevated without prior closed reduction. ORIF was carried out after recovery of the soft tissue. These groups were not of interest for our study and were excluded from further evaluation.

98 closed ankle fractures with tibiotalar dislocations (30%) were treated by means of closed reduction and delayed ORIF. Our trauma unit is the reference center of a heavily populated urban area. As distances are short, patients with suspected complicated fracture patterns and soft-tissue injury are often directly transferred to our institution and not to a smaller community hospital without a specialized trauma service. This policy explains the high percentage of complicated ankle fractures in our series.

Two patients had multiple injuries and were excluded from further evaluation. Exceptionally and deriving from our concept, two isolated ankle fractures were stabilized with an external fixator. The reason for preferring an external fixator over K-wire transfixation or plaster cast could not be explained retrospectively. These two patients were therefore excluded from our study as well. Two patients were transferred to other institutions after K-wire transfixation. Since no complete data sets were available for these patients, they were excluded from further analysis.

All of the remaining 92 patients sustaining an isolated closed ankle fracture with tibiotalar dislocation entered this retrospective study. There were 30 men (33%) and 62 women (67%). Mean age was 54 years (range 20–86 years).

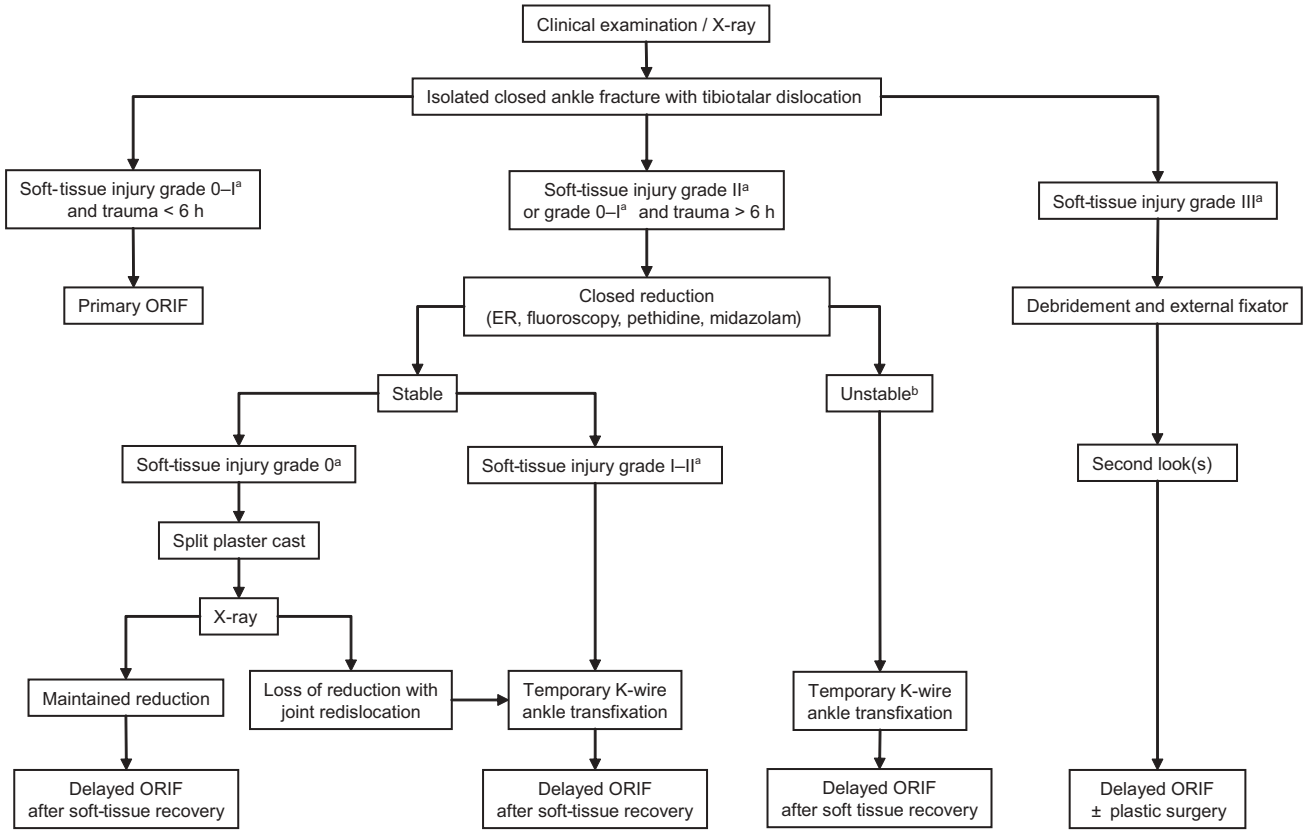
Decision making was based on specific criteria (Figure 1). The accompanying soft-tissue injury was assessed using the classification by Tscherne & Oestern [4] (Table 1). The two groups were formed according to our algorithm's entry criteria. There was no statistical difference between the K-wire group (KWG) and the plaster cast group (PCG) regarding gender and fracture classification. Patients were significantly older in the KWG (Table 2). K-wire transfixation of the ankle was performed in 42 cases (46%). In this study a total of twelve surgeons was involved. K-wire transfixation was performed by either experienced trauma surgeons or senior residents under supervision.

All ankles were transfixed using the same technique. Standard antibiotic single-shot prophylactics (second-generation cephalosporin) and low molecular weight heparins were given. Following closed reduction under sterile conditions in the operating room assisted by fluoroscopy (only one image intensifier was used), the foot was maintained in a neutral position. Two small skin incisions were made at the plantar aspect of the hindfoot. Following blunt dissection of the soft tissues onto the inferior surface of the calcaneus, two K-wires (2 mm in diameter) were implanted parallel to each other through the calcaneus and talus into the intramedullary cavity of the tibia (Figure 2). The ends of the K-wires were shortened, bent and sunk under the skin. Incisions were closed with skin sutures. Postoperatively, a well-padded posterior plaster slab was applied to keep the foot in a neutral position. This plaster slab could easily be removed for inspection and treatment of the soft tissues without risking a fracture-redislocation. The affected leg was kept in an elevated position, and cold packs were applied to fight the swelling. Skin excoriations were treated with local antiseptics. All patients had a delayed ORIF according to the AO/ASIF techniques [1], when recovery of the skin and soft tissue was evident.

The patients with K-wire transfixation were retrospectively analyzed and compared with the group which underwent plaster cast immobilization (Table 3). Time interval between transfixation or immobilization in a plaster cast and definitive treatment was recorded. Operating time for transfixation was evaluated. Local and general complications were analyzed and compared.

Statistical Analysis

Continuous variables were compared using Mann-Whitney test. Categorical variables were compared using Fisher's exact test or χ^2-test when appropriate. P-values were two-sided and considered significant when < 0.05.



[a] classification system for soft-tissue injuries in closed fractures by Tscherne Oestern [4]
[b] immediate redislocation (joint line incongruity) after closed reduction

Figure 1. Proposed algorithm for displaced ankle fractures. ER: emergency room; ORIF: open reduction and internal fixation.

Results

Of 92 isolated closed ankle fractures which were considered not suitable for immediate ORIF, 50 (54%) had a closed stable reduction and were immobilized in a split plaster cast. In 42 cases (46%), K-wire ankle transfixation was performed at the time of injury for an unstable fracture following reduction and/or critical soft tissues according to our algorithm (Figure 1).

Operating time for K-wire transfixation of the ankle – starting with closed reduction and ending with completed skin closure – ranged from 5 to 65 min (Table 3). This wide range is partly explained with our unit's teaching function. Many fractures were treated by surgical residents supervised by an experienced trauma surgeon. From own experience, prolonged operating time is mostly due to difficulties in obtaining acceptable closed reduction. Implantation of the K-wires under fluoroscopic guidance is a simple procedure with minimal operative problems.

Delayed ORIF was carried out within 7 days (range 3–20 days) after implantation of the K-wires. This time interval was significantly longer compared with the PCG.

Three patients (7%) in the KWG sustained local complications (skin blisters and superficial skin necrosis). These complications were related to the initial damage to the soft-tissue envelope and were not the re-

Table 1. The Tscherne & Oestern classification system for soft-tissue injuries in closed fractures [4].

Grade	Description
0	Minor soft-tissue damage, simple fracture types
I	Superficial excoriation, contusion, simple and moderately severe fracture types
II	Deep contaminated excoriation, circumscribed skin and soft-tissue contusion. Imminent compartment syndrome. Moderately severe and severe fracture types
III	Extensive skin and muscle contusion, subcutaneous decollement, decompensated compartment syndrome, different fracture types

sult of K-wire implantation. One patient underwent debridement and skin grafting before ORIF. All other local complications healed with local treatment. No wire breakage, fracture-redislocation or complex regional pain syndrome (CRPS, also: reflex sympathetic dystrophy) occurred. Despite transarticular fixation, no septic arthritis was seen. At the time of ORIF, all wires were easily removed without further complications.

The lateral plantar nerve lies medial and anterior to the path of the K-wires. In order to avoid an injury to this nerve which could result in loss of sensation of the lateral portion of the sole, we recommend blunt dissection of the soft tissues and the use of a drill sleeve. We have observed no damage to this nerve in our patients.

Table 2. Demographic data and statistical comparison of Kirschner wire group (KWG) versus plaster cast group (PCG). SD: standard deviation.

	KWG (n = 42)	PCG (n = 50)	P-value
Mean age [years ± SD (range)]	60 ± 13 (29–86)	50 ± 17 (20–86)	< 0.05*
Gender			
• Male	10 (24%)	20 (40%)	
• Female	32 (76%)	30 (60%)	
AO classification			0.42***
• A	0 (0%)	2 (4%)	
• B	28 (67%)	32 (64%)	
• C	14 (33%)	16 (32%)	
Soft-tissue injuries[a]			< 0.05***
• 0	11 (26%)	50 (100%)	
• I	23 (55%)	0 (0%)	
• II	8 (19%)	0 (0%)	
• III	0 (0%)	0 (0%)	
Stability after closed reduction[b]			< 0.05***
• Stable	9 (21%)	50 (100%)	
• Unstable	33 (79%)	0 (0%)	

*Mann-Whitney test
**Fisher's exact test
***χ^2-test
[a] Tscherne & Oestern classification system [4]
[b] Ankle fractures with immediate redislocations with joint line incongruity after closed reduction under fluoroscopic guidance were considered unstable. Stable fractures showed congruent joint lines. Slight displacement of the fracture was accepted

Local complications were observed in five patients (10%) following application of a split plaster cast (PCG). Two patients (4%) had skin blisters with superficial skin necrosis. One of these complications was caused by a too tight plaster cast with insufficient padding. The subsequent pressure sore healed with local treatment. Additionally, three fracture-redislocations (6%) occurred (Figures 3a to 3f). These patients presented with different fracture patterns (AO A2.3, C1.1, C2.3). They were considered stable after closed reduction, but subsequent X-rays showed a redislocation with an incongruent joint line. Obviously, the primary assessment of these fractures was wrong and subsequent X-rays revealed their true nature. All three ankles underwent a second closed reduction and K-wire transfixation within 2 days after the initial trauma. Delayed ORIF was performed between 5 and 8 days later without further complications.

In addition to the complications related to primary treatment, we observed more local complications following ORIF, two in the KWG (5%) and five in the PCG (10%). In the KWG, one osteosynthesis had to be redone due to implant failure (2%). Another patient presented with disturbed wound healing within 2 weeks after ORIF. Treatment was local. Only one general complication (2%) was recorded in this group (pneumonia and adult respiratory distress syndrome [ARDS]).

By contrast, ORIF failed in three patients of the PCG (6%). In one case Volkmann's fragment was insufficiently fixed in a bad position; another patient had to undergo a revision of the medial ligaments due to a persistent joint line incongruity after ORIF. In the third case screw fixation of the medial malleolus failed and had to be redone. Superficial skin necrosis was noted in one case (2%) which subsequently healed with local treatment. CRPS was diagnosed in one patient (2%). This patient had a second intervention after ORIF due to a persistent joint line incongruity (see above). CRPS was diagnosed within 2 weeks after ORIF. Complete remission was evident following appropriate medical treatment and physiotherapy. In a 60-year-old man with peripheral vascular obstructive disease, extensive disturbance of wound healing

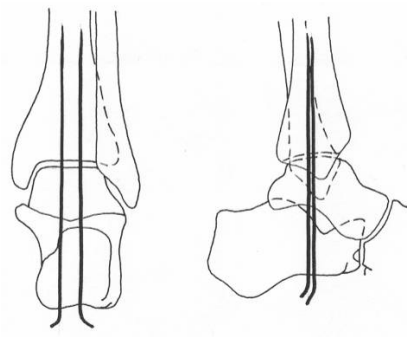


Figure 2. Correct position of Kirschner wires in respect to ankle anatomy (AP and lateral views).

Table 3. Results. CI: confidence intervall; KWG: Kirschner wire group; ORIF: open reduction and internal fixation; PCG: plaster cast group.

	KWG (n = 42)	95% CI	PCG (n = 50)	95% CI	P-value 95% CI
Mean operating time [min ± SD (range)]	30 ± 14 (5–65)	55–84	–	–	
Mean time to ORIF[a] [days ± SD (range)]	7 ± 4 (3–20)	7–31	5 ± 2 (2–13)	3–22	< 0.05*
Mean hospitalization [days ± SD (range)]	19 ± 10 (11–69)	30–61	17 ± 7 (8–42)	21–49	< 0.05*
Complications					
• Local complications after KW/PC	3 (7%)	1–19	5 (10%)	3–22	0.72**
• Local complications after ORIF	2 (5%)	1–16	5 (10%)	3–22	0.45**
• Systemic complications after KW/PC	1 (2%)	0–13	0 (0%)	0–7	0.46**
• Systemic complications after ORIF	1 (2%)	0–13	0 (0%)	0–7	0.46**
• Total complications	7 (17%)	7–31	10 (20%)	10–34	0.79**

*Mann-Whitney test
**Fisher's exact test
[a] time interval between K-wire transfixation or plaster cast immobilization and definitive treatment (ORIF)

with skin necrosis and infection occurred. Below-knee amputation was performed 14 days after ORIF.

The complication rate for primary treatment and delayed ORIF combined was 17% for the KWG and 20% for the PCG ($p = 0.79$). Mortality was 0% for both groups. Mean hospital stay was 19 days for the KWG compared with 17 days for the PCG ($p < 0.05$).

In summary, no significant difference was found between the two groups regarding complications. The more severe the soft-tissue injuries the longer it took them to recover. This resulted in a prolonged time interval from primary treatment to ORIF and, subsequently, to a longer hospital stay for the KWG.

Discussion

ORIF is generally accepted as the treatment of choice for most displaced, closed fractures of the ankle [1, 5–7]. Whenever possible, immediate operation is recommended before considerable swelling occurs.

However, open reduction at the time of injury may need to be delayed due to poor skin condition, swelling of the soft tissues, a critical systemic problem, or urgent treatment of other injuries with higher priorities [1, 2]. It is generally accepted that these conditions compromise early ORIF and lead to a higher incidence of local and systemic complications. Furthermore, Fogel & Morrey [8] and Konrath et al. [9] showed that for ankle fractures, delayed ORIF provides similar functional results compared with immediate ORIF.

Closed reduction and temporary immobilization in a well-padded split plaster cast is the initial treatment of choice, if ORIF has to be delayed. In our series, this modality was chosen for stable fractures where the skin and soft tissue were not in critical condition (grade 0). Unstable fractures of the ankle can rarely be maintained in a plaster [3, 10]. A firm fit of the plaster cast is mandatory to hold a closed reduction in these cases. This can be fatal to already compromised soft parts. When the swelling subsides, frequent changes of plaster holding might be necessary in order to maintain the reduction.

K-wire transfixation proves to be an effective and safe alternative for temporary stabilization of ankle fractures [11, 12]. Retention of reduction is reliable; we observed no redislocation in our series, and the morbidity of the procedure is low. Skin care and continued assessment of soft tissue are facilitated without risking further damage. Exceptionally and under special circumstances, K-wire transfixation can even be considered being a definitive treatment modality in combination with a plaster cast (patient not fit for surgery, persistent skin lesions) [11–14].

However, for the majority of patients, K-wire ankle transfixation is only temporary to maintain reduction in order to achieve the most efficient recovery of poor skin condition and compromised soft tissue. Delayed open reduction and stable internal fixation complete this staged operative treatment concept.

All patients were kept in hospital after K-wire transfixation. Compared to the PCG, the patients in the KWG were significantly older. Many of these patients had relevant comorbidities, and the damaged soft tissues demanded consequent elevation of the extremity and immobilization. The skin was inspected at least once a day. In our opinion, treating these patients on an outpatient basis between K-wire implantation and ORIF is neither safe nor convenient for the patients.

Alternatively, an external fixator provides excellent stability combined with protection of skin and soft tissue [15]. In comparison with external fixation, K-wire transfixation provides better access for inspection and

treatment of the soft tissues. With the K-wires bent and sunk under the skin, wire tract infection is not seen. Therefore, we no longer use the more invasive external fixator for these fracture patterns.

A weakness of our study is the comparison of the KWG and the PCG, given the risk of being able to draw reliable conclusions between the two groups. The two groups were formed according to specific criteria, based on potential or already evident problems and complications at the time of injury. Likewise, they were selected according to the injury pattern and no randomization took place. The two groups showed no difference regarding the distribution of gender and fracture classification, whereas the patients in the KWG were significantly older and most fractures in this group were unstable after reduction with damaged soft tissues (grade I–II). By contrast, the PCG contained only stable fractures with an adequate soft-tissue envelope (grade 0). As the patients in the KWG were significantly older, our series indicate that injuries to the soft tissues in ankle fractures tend to be more common in elderly patients. Despite the differences in age and soft-tissue damage no significant difference between the two groups was found regarding local complications. While no ankle stabilized by means of K-wire transfixation presented with redislocation prior to ORIF, three ankles could not be held in the plaster cast and transfixation was required. Our results indicate when K-wire transfixation is used, a high grade of stability is obtained along with providing the best conditions for complete recovery of the soft parts without causing further damage.

Figures 3a to 3f. Case example of a severely displaced ankle fracture with tibio-talar dislocation. a and b) Persistent dislocation after unsuccessful closed reduction and application of a split plaster cast (AP and lateral views). c and d) Result after closed reduction and Kirschner wire transfixation (AP and lateral views). e and f) Final result after ORIF (AP and lateral views).

Anatomic reduction is not the aim when ankle transfixation is performed [12]. Restoration of the normal relationship between tibia and talus is important. Closed reduction should be achieved with as little manipulation as possible. Prolonged and forceful maneuvers bear the risk of causing even more damage to already compromised skin and soft tissues. Unlike Seibert et al. [12], we do not routinely drill the K-wires through the ventral cortex of the tibia. We do not think that this detail is important, if transfixation is intended to be only temporary. We encountered no wire loosening, wire breakage or fracture-redislocation, using the technique as previously described. However, we do agree that perforation of the ventral cortex of the tibia is important, if transfixation is intended to be the definitive treatment. In this rather rare situation, risk of wire breakage is increased due to long-term transfixation unless external immobilization is used. Additionally, removal of the broken wire is facilitated, if the ventral cortex of the tibia is perforated, providing easy access to the tibial wire. In accordance with Seibert et al. [12], we are convinced that diameter and number of the wires used are crucial. Seibert et al. reported one redislocation with wires < 2 mm in diameter. They also observed a significantly higher infection rate when more than two retrograde wires were used. These observations are supported by our experience. We encountered no septic arthritis, deep infection, or fracture-redislocation in the KWG. In contrast to other authors [3, 11, 14] who described other techniques using only one Steinmann pin, we always use two wires to increase rotational stability.

The damage to the joint's articular surface by the penetrating K-wires is a major concern. However, no paper in the literature was found which attributed posttraumatic degeneration of the ankle to the transfixation. In 1976, Childress published a study of 92 consecutive patients treated definitively by means of ankle transfixation with a follow-up of 1–16 years [13]. Traumatic arthritis was the most common late disabling factor, which, however, was not related to the pin penetration areas of the ankle joint.

If immediate ORIF for ankle fractures cannot be done due to persistent instability after closed reduction, compromised condition of skin or soft tissues, temporary Kirschner wire transfixation of the ankle is a safe and effective treatment option. Reliable stability is achieved with low morbidity.

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