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Impact of the fibula fractures and syndesmotic injuries on the prognosis of the tibial pilon fractures

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Aim: To evaluate tibial pilon fractures, as well as the type of fibula fracture, and the presence of injury to the inferior tibiofibular joint.

Materials and methods: The study included 42 patients (34 male, 8 female) who underwent surgery for pilon fractures and were followed up. The mean follow-up period of the patients was 72 months (range: 36-102 months). The patients were classified into 2 groups as Ruedi-Allgower (RA) Type II, including 20 patients and RA Type III, including 22 patients. The fibula fractures of the patients were classified according to the Weber classification. The reduction quality was determined by evaluating the early postoperative graphs of the patients based on the scale defined by Conroy et al. The standard anterior-posterior and side graphs were investigated for arthrosis. The clinical evaluation of the ankles of the patients was based on the rating scale of Teeny and Wiss.

Results: In the RA Type II group, Weber B fibular fractures were significantly more common and, in the RA Type III group, Weber C fibular fractures were significantly more common ($P < 0.001$). Comparisons of the fibular fracture types revealed that in Weber Type C fractures, the incidence of posttraumatic arthrosis was higher ($P < 0.05$). The clinical evaluations recorded on the final controls of the patients showed that sufficient outcome was achieved in 55% of the patients with RA Type II fractures and in 45.5% of the patients with the RA Type III fractures.

Conclusion: The type of fibular fracture and the presence of syndesmotic injury affect the functional outcome of pilon fractures.

Key words: Tibial pilon fracture, fibula fracture, syndesmotic injuries

Fibula kırıkları ve sindezmotik yaralanmaların pilon kırıklarının prognozuna etkisi

Amaç: Tibia pilon kırıklarının, fibula kırıklarının tipi yönünden olduğu gibi aynı zamanda inferior tibiofibuler eklemde hasar varlığı yönünden de değerlendirmektedir.

Yöntem ve gereç: Bu çalışma tibia pilon kırığı nedeniyle cerrahi girişim geçirmiş ve takip edilmiş olan 42 hastanın (34 erkek, 8 bayan) sonuçlarını içermektedir. Ortalama takip süresi 72 aydır. (36-102). Hastalar Ruedi-Allgowers sınıflamasına göre 2 gruba ayrılmıştır. (RA) tip II 20 hasta; (RA) Tip III 22 hastayı içermektedir. Fibula kırkları Weber sınıflamasına göre değerlendirilmiştir. Redüksiyon kalitesi Conroy ve ark. tarafından tanımlanmış skalaya göre, erken postoperatif grafilerle değerlendirilmiştir. Artroz standart Ap ve Yan gafilerle değerlendirilmiştir. ayakbileğinin klinik Teeny ve Wiss 'in değerlendirme skalası ile değerlendirilmiştir.

Bulgular: (RA) Tip II grubunda Weber B fibula kırıkları; (RA) Tip III grubunda ise Weber Tip C fibula kırıkları belirgin şekilde yüksektir $P < 0,001$). Fibula kırıklarının tipleri karşılaştırıldığında Weber Tip C kırıklarında posttravmatik artroz oranı daha yüksek bulunmuştur ($P < 0,05$). Son kontrollerinde yapılan klinik değerlendirmede, (RA Tip II grubunda hastaların % 55'inde; (RA) Tip III grubunda ise % 45,5'inde tatmin edici klinik bulgular elde edilmiştir.

Sonuç: Fibula kırıklarının tipi ve sindezmotik yaralanma pilon kırıklarında fonksiyonel sonuçları etkilemektedir.

Anahtar sözcükler: Pilon kırığı, fibula kırığı, sindezmoz yaralanması

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Introduction

Tibial pilon fractures are uncommon and difficult to manage. Because the weight bearing articular area of the tibia is involved, the aim of treatment is directed towards achieving tibial articular congruence, alignment, and bony stability. In tibial pilon fractures, the presence of a fibula fracture, its type, and injury of the inferior tibiofibular joint are usually shadowed by the injury to the tibia, and thus they do not receive the attention they deserve. However, fibular fractures occur commonly as a component of the overall injury pattern in tibial pilon fractures. There are few clinical or biomechanical data, however, associating the status of the fibula with any injury pattern of the tibial plafond. Similarly, the integrity of the fibula is not assessed in the commonly used tibial pilon fracture classification schemes (1,2). Schatzker and Tile (3) previously suggested a mechanistic and morphologic difference in distal tibial injuries that occur with and without fibula fractures (4).

This study evaluated tibial pilon fractures, as well as the Type of fibula fracture, and the presence of injury to the inferior tibiofibular joint. In addition, the effects of these injuries on the functional outcome of tibial pilon fractures were investigated.

Materials and methods

The study included 42 patients (34 male, 8 female) who underwent surgery between 1999 and 2004 for pilon fractures and were followed up. The mean age of the patients was 43.37 years (range: 17-75 years). The fractures of 31 patients were located on the right and those of 11 patients were located on the left. The mean follow-up period of the patients was 72 months (range: 36-102 months).

The data of the patients with tibial pilon fractures who present to our department have been recorded since 1999. The patients eligible for the study based on the data obtained from their files were contacted by telephone and/or letter. A team of orthopedists with different levels of experience was formed to evaluate the patients. The standard ankle and anterior-posterior side graphs of the patients obtained upon presentation were evaluated and the types of fractures were classified according to the criteria of Ruedi-Allgower (RA). Patients with RA Type I were not included in the study.

The patients were classified into 2 groups as RA Type II and Type III. The radiographies of both of the groups were studied for fibula fractures and syndesmosis injury. The fibula fractures of the patients were classified according to the Weber classification. In the anterior-posterior graphs of the patients without fibula fractures, syndesmosis was determined by measuring the distance between 1 cm above the ankle and the radiodense line of the tibiofibular notch and fibula medial cortical surface. Values over 5 mm were considered positive.

K wires were passed through the tibial diaphysis, juxta-articular tibial area, and calcaneus in the fractures treated with an ilizarov external fixator. To achieve 1 cm ankle joint space, distraction was applied. In all of the patients, mobilization with partial weight-bearing (25% of the total weight) was allowed on postoperative days 5 to 11. After a mean 22 days, the patients stopped using crutches and were mobile with total weight-bearing. After callus formation was observed radiologically, the calcaneal ring was removed, at an average of 29.8 days (20-33 days). The external fixator was removed after a mean of 122.4 days (111-144 days), when new bone tissue and regeneration were mature based on the radiological evaluation

The open fractures had been classified according to the Gustilo-Anderson method. The causes of the fractures were determined based on the records of the patients (Table 1).

Table 1. The distribution of injury mechanisms and open-fracture types.

	Groups	
	RA Type II	**RA Type III**
Injury mechanism		
Traffic accident	8	11
Fall	8	6
Occupational accident	2	4
Sports injury	1	0
Other	1	1
Open-fracture type		
Gustilo I	2	2
Gustilo II	4	3
Gustilo III	1	3

The reduction quality was determined by evaluating the early postoperative graphs of the patients based on the scale defined by Conroy et al. (5) as excellent for <2 mm of joint incongruity and <5° of varus/valgus metaphyseal-diaphyseal angulation, satisfactory for >2 mm but <5 mm of joint incongruity or fracture plane separation and >5° of varus/valgus metaphyseal-diaphyseal angulation, and poor for >5 mm of joint incongruity or fracture gap and >10° of varus/valgus metaphyseal-diaphyseal angulation. Excellent and good reductions were considered sufficient outcomes. The postoperative graphs of the patients whose fibulas were fixed were evaluated for reduction quality.

Evaluation of the treatment methods of the patients showed that 10 of the RA Type II fractures were treated by using an external ilizarov fixator; 10 were treated by open reduction internal fixation (ORIF), and of the RA Type III fractures, 15 were treated by using an external ilizarov fixator and 7 were treated by ORIF, and all of the fibula fractures were treated by plate-screw fixation. Syndesmotic ligament injury was treated by using olive K wire in external ilizarov fixation procedures, and by using screws in ORIF procedures.

In 5 patients, fractures were accompanied by a calcaneus fracture on the opposite extremity; in 2 patients, by a bimalleolar fracture on the opposite extremity; in 1 patient, by an acetabulum fracture on the same side; and, in 2 patients, by a femur distal shaft fracture on the same side.

The standard anterior-posterior and side graphs of the ankles of the patients were obtained in the last follow-up visit and evaluated by the team. The graphs were investigated for arthrosis. A narrowing of 50% or more in the joint space and presence of sclerotic changes were considered positive.

The clinical evaluation of the ankles of the patients was based on the rating scale of Teeny and Wiss (6). In this system, subjective and objective clinical findings such as walking distance, supports or orthosis requirement, running ability, toe raising, hills up or down, stairs up or down, limping or not, plantar range of motion of the ankles, dorsal range of motion, and swelling were evaluated. The maximum score was 100, but a score of 93-100 was considered excellent; 87-92, good; 65-86, moderate; and 0-64, poor outcome. In our study, we considered excellent and good outcome, sufficient, moderate, and poor outcome, and insufficient outcome.

Statistical analysis was performed using the SPSS 10.0. Groups were compared using a chi-square test or a Fisher's exact test. $P < 0.05$ was considered statistically significant.

Results

Of the pilon fractures, 20 were determined to be Type II and 22 Type III. The distribution of the fibula fractures and syndesmotic injury according to groups is shown in Table 2.

Table 2. The distribution of type of fibular fracture and syndesmotic injury according to the groups.

	Groups	
	RA Type II	**RA Type III**
Fibula fracture		
Weber B	12	4
Weber C	4	13
Syndesmosis injury	3	4
No fib. fract. or synd. injury	1	1
Total	20	22

Of the RA Type II fractures, 16 were fibular fractures (12 Weber Type B and 4 Weber Type C). Three of the patients with RA Type II fractures but no fibular fractures also had syndesmotic injury.

Of the RA Type III fractures, 17 were fibula fractures (4 Weber Type B and 13 Weber Type C). Four of the patients with RA Type III fractures but no fibular fractures also had syndesmotic injury.

The statistical evaluation showed significant differences between the groups for the distribution of fibular fracture types ($P < 0.001$). Accordingly, in RA Type II fractures, Weber B are more common and, in RA Type III fractures, Weber C fibular fractures. However, no statistically significant differences were determined between the groups for syndesmotic ligament injury ($P > 0.05$).

The reduction quality results based on the early postoperative graphs of the patients were distributed according to treatment methods used (Table 3).

Sufficient reduction quality (excellent and good reduction) was achieved at a rate of 70% in the RA Type II group treated with an ilizarov external fixator and 80% in the group treated by ORIF, and 46.6% in the RA Type III group treated with an ilizarov external fixator and 71.4% in the group treated by ORIF.

In all of the fibular fractures fixed by using plates and screws, anatomical reduction was determined according to the early postoperative graphs. In addition, all of the patients who had undergone fixation due to diastasis, it was found that the distal tibiofibular space was within normal limits after recovery.

Using the final control graphs of the patients, posttraumatic ankle arthrosis was evaluated considering the treatment methods used, and fibula fracture types, and syndesmotic injury of the patients (Table 4).

Posttraumatic arthrosis was detected in 40% of the patients with RA Type II fractures and in 50% of the patients with RA Type III fractures. Of the 7 patients with RA Type II fibula fractures and posttraumatic arthrosis, 4 had Weber Type C and the remaining 3 had Weber Type B fractures. Of the 9 patients with RA Type III fibular fractures and posttraumatic arthrosis, 8 had Weber Type C fractures and the remaining 1 patient had a Weber Type B fracture. Comparisons of the fibular fracture types revealed that in Weber Type C fractures the incidence of posttraumatic arthrosis was higher ($P < 0.05$).

Table 4. The distribution of posttraumatic ankle arthrosis according to the groups.

	Posttraumatic arthrosis
RA Type II	
Ilizarov external fixator	5
ORIF	3
Fibula fracture	7
Syndesmotic ligament injury	1
RA Type III	
Ilizarov external fixator	8
ORIF	3
Fibula fracture	9
Syndesmotic ligament injury	2

The clinical evaluations recorded on the final check-ups of the patients showed that sufficient outcome was achieved in 55% of the patients with RA Type II fractures and in 45.5% of the patients with RA Type III fractures (Table 5). However, no statistically significant differences were found between the groups ($P > 0.05$)

Based on the evaluation of the outcomes achieved regardless of the RA fracture types, insufficient outcome was obtained in 64.7% of the Weber Type C fractures (11 patients) and in 43.8% of the Weber Type B fractures (7 patients). The rate of insufficient

Table 3. The distribution of the reduction quality according to treatment methods.

	Reduction quality			
	Excellent	Good	Poor	Total
RA Type II				
Ilizarov external fixator	2	5	3	10
ORIF	6	2	2	10
RA Type III				
Ilizarov external fixator	2	5	8	15
ORIF	2	3	2	7

Table 5. The distribution of clinical evaluation findings according to the groups.

	Clinical evaluation				
	Excellent	Good	Moderate	Poor	Total
RA Type II					
Ilizarov external fixator	2	3	3	2	10
ORIF	3	3	3	1	10
RA Type III					
Ilizarov external fixator	2	4	5	4	15
ORIF	3	1	2	1	7

outcome was significantly higher in Weber Type C fractures. In 4 of the 7 patients with syndesmotic injury (57.1%), the outcome was insufficient.

Because nonunion was determined in 1 patient with RA Type II treated with an ilizarov external fixator, in 1 patient with RA Type II treated with ARIF, in 2 patients with RA Type III treated with an ilizarov external fixator, and in 1 patient with RA Type III treated with ARIF, autogenous grafting was performed. Of the patients who had undergone ARIF, 4 had developed skin problems; thus, a flap-graft was applied in these patients. In 2 patients with Gustilo 3 open fractures, deep infections developed; thus, repeated debridement and parenteral antibiotics were applied in these patients.

Discussion

The injury mechanisms or the severity of tibial plafond fractures are generally evaluated without regarding the status of the fibula (3). The classification systems commonly used for distal tibial fractures include the Ruedi-Allgower system (1) and the AO/OTA Fracture Classification System (2). Although both are descriptive systems, the severity of injury is only inferred. Additionally, with the Ruedi-Allgower system, poor interobserver and intraobserver agreement has been shown (7). Furthermore, it seems impossible to include all of the parameters required to accurately assess the severity of an injury in one classification system.

In our study, we evaluated the types of fibular fractures accompanying tibia pilon fractures and the presence of syndesmosis injury. The study was based on the theory that fibula fractures accompanying tibial pilon fractures may affect the functional outcome. Pilon fractures are usually classified according to RA classifications. However, this system is more focused on the tibia than the fibula; thus, fibula fractures are often overlooked. In this study, fibular fractures were evaluated based on the Weber classification. In this classification, if the location of the fracture is below the syndesmosis, the fracture is classified as Weber A; if at the same level, it is classified as Weber B; and, if above the syndesmosis, it is classified as Weber C. In this system, the severity of syndesmosis injury increases as the fracture type shifts from Weber A to C. Syndesmosis injury causes instability in the ankle, which in turn results in dynamic incongruity, affecting ankle functions. The patients in our study were divided into 2 groups as RA Type II and RA Type III, and their fibula fractures were evaluated (Figures 1a, 1b, and 1c and Figures 2a, 2b, and 2c). The type of fibula fractures of the groups was significantly different ($P < 0.001$). The incidence of Weber B was higher in the RA Type II group and Weber C was more common in the RA Type III group. In the RA classification, the severity of trauma increases as the fracture type increases from Type II to Type III. At the same time, the severity of the accompanying fibula fracture and syndesmosis injury also increases. The treatment of fractures of the distal tibial plafond is challenging for the orthopedic surgeon (8-10). In 1969, Ruedi and Allgower (11) reported 74% excellent or good results when they reviewed 84 pilon fractures treated with ORIF. Previous studies have demonstrated significant differences in outcomes based on the

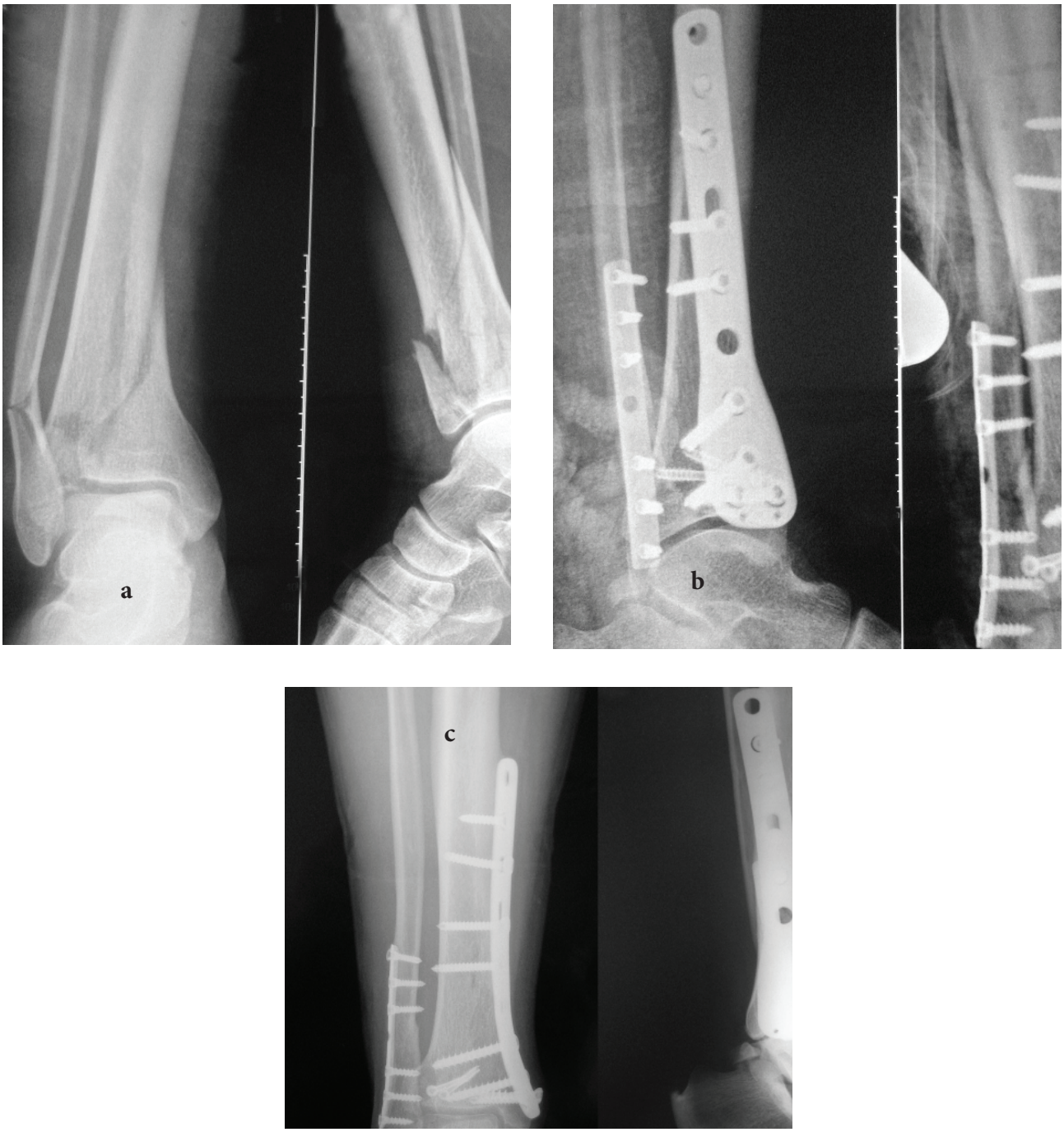

Figure 1. The case of a 37-year-old patient, treated with plate-screw: a) preoperative, b) postoperative, and c) month 32 of follow-up.

clinical characteristics of the fracture types (6,9). In the present study, the satisfactory clinical outcome of Ruedi in Type III fractures was 44.4%, which was significantly lower ($P < 0.05$) than that of Ruedi in Type I (87.2%) or Type II fractures (79.0%).

In the literature, poorer functional outcome has generally been reported with RA Type III fractures. In our study, sufficient outcome (excellent-good) was achieved in 55% of the patients with RA Type II fractures and in 45.5% of the patients with RA Type

Figure 2. The case of a 49-year-old patient, treated with an ilizarov external fixator: a) preoperative, b) postoperative, and c) month 25 of follow-up.

III fractures. However, no statistically significant differences were found between the groups ($P > 0.05$). The evaluation of the outcomes achieved, regardless of the RA fracture types, showed that insufficient outcome was obtained in 64.7% of the Weber Type C fractures (11 patients) and in 43.8% of the Weber Type B fractures (7 patients). The rate of insufficient outcome was significantly higher in Weber Type C fractures. This suggests that RA classification often helps predict prognosis; however, in our study, despite a mean 72 months of follow-up period, functional evaluation showed no significant differences between the groups for RA types. Nevertheless, comparisons of the fibular fracture types show that a fibular fracture affects prognosis.

The initial type of fracture and joint cartilage injury are associated with delayed arthritic changes, depending on the severity of the trauma. Degenerative changes are known to develop in the long term, depending on the quality of reduction

achieved (12,13). However, despite anatomical reductions, joint cartilage injury associated marked arthrosis development has been reported to occur during the follow-up (6,13-18). In our study, posttraumatic arthrosis was detected in 40% of the patients with RA Type II fractures and in 50% of the patients with RA Type III fractures. Comparisons of the fibular fracture types revealed that in Weber Type C fractures, the incidence of posttraumatic arthrosis was higher.

Barei et al. (4) evaluated the difference in the radiographic severity of tibial pilon injuries with fibular fractures compared with those without fibular fractures. In their study, using the rank order method, tibial pilon injuries with fibular fractures were statistically ranked as more severe than those without fibular fractures. While they compared the fractures accompanied by fibular fractures with those unaccompanied by fibular fractures, our study compared the different types of accompanying fibular fractures. Considering the fact that fibular fractures accompany most of the tibial pilon fractures, it should be kept in mind that as well as the presence of a fibular fracture, its type may also affect the prognosis. In our study, the outcome was insufficient in 57.1% of the patients with no fibula fractures but with syndesmotic injury. Thus, syndesmosis injury may also affect the prognosis.

One limitation of the study was different treatment methods used in both groups of patients. The effects of treatment method on functional outcome have been reported in many studies. Another limitation was the diagnosis of syndesmosis injury by direct radiographic measurements. Magnetic resonance imaging (MRI) would have been a better alternative in evaluating this kind of injury in detail.

In conclusion, the type of fibular fracture and the presence of syndesmotic injury affect the functional outcome of pilon fractures. Nevertheless, combined use of RA and Weber classifications may aid in determining the severity of the trauma.

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