

Plate fixation versus percutaneous rush pinning for osteosynthesis of the fibula in pilon fractures. A retrospective comparative study

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Abstract

Background: Pilon fractures are complex injuries of the ankle associated with many postoperative complications. The optimal treatment for pilon fractures has not yet been established. This study aimed to determine the efficacy and compare the results of percutaneous rush pinning of the associated fibular fracture to the conventional open reduction and internal fixation.

Methods: We included in the study all patients admitted in our department with the diagnosis of pilon fracture and associated fracture of the distal fibula and treated with primary open reduction and internal fixation between 2012 and 2018. We excluded patients treated with a two-stage approach, and those with an open fracture or neurovascular insufficiency.

Results: The study included 87 patients; 45 had their distal fibular fracture operatively fixed with a one-third tubular plate (ORIF group), and the remaining 42 patients underwent percutaneous intramedullary pinning of the fibula fracture with a rush nail (Rush group). There were no statistically significant differences between the groups regarding age, gender, mechanism of injury, operating, and hospitalization time. The superficial infection rate was lower in the Rush group ($p = 0.039$), but there were no statistically significant differences in the deep tissue infection, nonunion, and malunion incidence between the groups.

Conclusion: Percutaneous intramedullary rush pinning of the concomitant fibular fracture is a safe and reliable alternative treatment option in managing pilon fractures that could reduce the incidence of postoperative wound complications
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Keywords: Pilon, Rush nail, percutaneous, fibular fracture

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Introduction

Intra-articular fractures of the tibial plafond, commonly referred to as pilon fractures, are infrequent injuries, which account for approximately 7 % of all the tibial fractures¹. Pilon fractures are most commonly high-energy injuries resulting from axial loads, such as motor vehicle accidents or falls from height². Fractures of the tibial plafond are typically characterized by articular impaction, metaphyseal comminution, and soft tissue injuries and are often associated with distal fibular fractures³.

Computed Tomography (CT) imaging is essential for fracture classification and preoperative planning and provides an excellent delineation of the articular involvement^{4,5}. Conservative management is a valid option for non-ambulatory patients, those with severe comorbidities, or stable fracture patterns with an intact articular surface⁶. Nevertheless, the vast majority of the pilon fractures are treated operatively. Joint-spanning external fixation can be used successfully for temporary stabilization until swelling resolves and soft tissue healing occurs⁷. Open reduction and internal fixation (ORIF) is the

mainstay of treatment and can be performed acutely or in a staged fashion⁸. Primary ankle arthrodesis combined with fracture reduction is a reliable option in a selective group of patients with highly comminuted fractures and severe articular damage⁹.

Several complications have been reported, including wound dehiscence, superficial or deep tissue infection, malunion, stiffness, and post-traumatic arthritis¹⁰⁻¹². Superficial wound infection is the most common complication encountered in treating tibial plafond fractures¹³; however, it is usually managed nonoperatively with local wound care and oral antibiotics.

Despite the numerous studies in this area, the optimal treatment for tibial pilon fractures is yet to be determined. Controversy still exists regarding the fixation method and the appropriate timing for surgery. The two-stage approach, which includes primary fixation with an external fixation device followed by definitive internal fixation, is the most commonly used method^{1,14,15}. Nevertheless, this method is associated with a prolonged hospitalization¹⁶, longer operating times¹⁷, and a higher risk of

nonanatomic reduction¹⁸. On the other hand, the primary internal fixation is associated with a higher risk of wound complications, such as wound dehiscence, infection, or skin necrosis, especially when the fixation is performed through a dual-incision approach^{18,19}.

There are various fixation methods for managing the associated fibular fracture, and the choice is largely based on the individual surgeon's preferences and familiarity with each technique. The present study aimed to compare the effectiveness and complication rate of two different fixation methods of the associated distal fibular fracture, open reduction and internal plate fixation, and percutaneous rush intramedullary pinning.

Materials and Methods

Study design

This retrospective study obtained an exemption decision from Papageorgiou hospital's Institutional Review Board. The files of all the patients received the standards of care according to the AO foundation treatment guidelines during their hospitalization. The study was conducted in January 2019. All patients admitted to our department with the diagnosis of a pilon fracture between January 2012 and July 2018 were reviewed. We set the following inclusion criteria: i) type III tibial plafond fracture, based on Ruedi and Allgower classification (i.e., fracture with a comminuted articular surface, AO/OTA type 43.C), ii) associated distal fibular fracture, iii) primary ORIF treatment, and iv) minimum 12-month follow-up. The exclusion criteria were: i) two-stage approach, ii) open fracture, iii) pathological fracture, iv) diabetes or other causes of neurovascular insufficiency,

and v) lack of follow-up information. The data were extracted from the hospital records and the outpatient department notes.

Surgical technique

All the operations were performed by our department's senior orthopedic trauma surgeons. Preoperative anteroposterior and lateral radiographs were obtained, and CT-scans if needed. The timing of surgery depended on the skin condition and was delayed in case of severe swelling until a "wrinkle sign" occurred. In those cases, a temporary splint was applied. Since both ORIF and percutaneous rush intramedullary pinning for the management of the fibular fracture are valid options, the fixation method was based on the individual surgeon's preference and familiarity with the each technique.

All the patients were treated with a standard single-stage ORIF under intraoperative fluoroscopy. With the patient in a supine position and under tourniquet, the fibular fracture was managed as a first step. It was fixed either by ORIF with a one-third tubular plate using a posterolateral approach (ORIF group) (Figure 1) or percutaneously with an intramedullary rush nail (Rush group) (Figure 2). The rush nails were controlled with a T-handle chuck and advanced from the distal fragment to the proximal one without opening the fracture site. In all cases, the distal end of the nail was bent and impacted into the lateral malleolus to avoid skin irritation. Next, an anteromedial approach of the distal tibia was performed, followed by direct visualization of the articular surface and preliminary reduction and stabilization with Kirschner wires. A metaphyseal locking plate (LCP) for



Figure 1: Anteroposterior (A) and lateral (B) views of a plain radiograph of the lower leg showing a Pilon fracture treated with open reduction and internal fixation (ORIF) with a locking plate (LCP) of the distal tibia and a one-third tubular plate of the distal fibula.



Figure 2: Anteroposterior (A) and lateral (B) views of a plain radiograph of the lower leg showing a Pilon fracture treated with open reduction and internal fixation (ORIF) with a locking plate (LCP) of the distal tibia and percutaneous intramedullary Rush pinning of the distal fibula.

the distal media tibia of adequate length was inserted and secured with a combination of locking and non-locking screws. Small buttress plates and lag screws were used when needed to fix the articular fragments. Cancellous allografts were used in cases of large bone defects. Restoration of articular congruence was achieved in all cases. Care was taken to ensure a skin bridge of a minimum of seven cm between the two incisions.

Postoperatively, an identical protocol was used for patients in both groups. Active assisted ankle exercises were encouraged immediately after surgery, except if wound healing problems were encountered. All patients were followed-up two weeks and one month after surgery and then monthly until the bony union was confirmed radiographically. Full weight-bearing was typically initiated three months post-surgery. Patients were followed up for at least one year.

Outcome measures

The primary outcomes measured included the operating time, the hospitalization time, and the rates of complications. Wound infection was considered to be superficial when it could be managed nonoperatively with local wound care and oral antibiotics (Figure 3). Deep tissue infection was defined as an infection requiring surgical intervention and intravenous antibiotics (Figure 4). Tibia or fibula nonunion was defined as the absence of radiological evidence of bone healing after nine months from surgery²⁰. Malunion of the tibia or fibula was defined as angulation of more than 7° in the coronal plane and more than 10° in the sagittal plane²¹. Patient demographic characteristics, including age, gender, and mechanism of injury, were also recorded.

Statistical analysis

The statistical analyses were conducted utilizing the IBM SPSS Statistics for Windows, Version 21.0 (IBM Corp., Armonk, NY, USA). Continuous variables are given as means and standard deviation, while nominal variables are expressed as the number of cases and percentages. To determine whether data were normally distributed, we used the Shapiro-Wilk test. We analyzed continuous variables utilizing the independent samples t-test or the Mann-Whitney U-test, while categorical variables were analyzed with Pearson's chi-square test or Fisher's exact test. A p-value of less than 0.05 was considered to be statistically significant.

Results

Overall, the study included 87 patients with a pilon fracture treated operatively with primary ORIF. In particular, 45 patients (51.72 %) had their distal fibular fracture operatively fixed with a one-third tubular plate (ORIF group). The remaining 42 patients (48.28 %) underwent percutaneous intramedullary pinning of the fibula with a rush nail (Rush group). The average follow-up time for the ORIF group was 21.4 (range 14-36) months and for the Rush group 20.9 (range 14-24) months. The patients



Figure 3: Postoperative image of the wound demonstrating a superficial wound infection, managed nonoperatively with oral antibiotics and local wound care.



Figure 4: Postoperative image of the wound demonstrating a deep tissue infection that required surgical intervention and intravenous antibiotics.

in both groups had no significant differences with respect to age (Mann-Whitney U =801.0, n1 =45, n2 =42, p =0.222), gender (x2 =3.35, df=2, p =0.187), and mechanism of injury (x2 =2.57, df=2, p =0.277). No statistically significant differences were observed between the two groups in the operating time (Mann-Whitney U =814.5, n1 =45, n2 =42, p =0.267) and the hospital stay (Mann-Whitney U =918.0, n1 =45, n2 =42, p =0.820) (Table 1).

The incidence of complications in both groups is presented in Table 2. Eight patients with deep tissue infection (six in the ORIF group and two in the Rush group) required surgical debridement and intravenous antibiotics. The infection was resolved in all the cases. A total of five patients developed nonunion (two in the ORIF group and three in the Rush group), and there were two patients in the Rush group with fracture malunion. No significant

Table 1: Demographic data, operating, and hospitalization time for the 87 patients with Pilon fracture and associated fracture of the distal fibula, treated with primary open reduction and internal fixation and comparison between the 45 patients who had their distal fibular fracture operatively fixed with a one-third tubular plate (ORIF group) and the 42 patients who underwent percutaneous intramedullary pinning of the fibula with a rush nail (Rush group).

		ORIF group (n =45)	Rush group (n =42)	p-value
Gender	Male	15	18	0.187
	Female	27	24	
Age (years)		51.33 \pm 15.27	54.14 \pm 11.57	0.222
Mechanism	Fall on level ground	24	21	0.277
	Fall from height	6	11	
	Motor vehicle accident	15	10	
Operating time		85.78 \pm 13.32	82.31 \pm 10.71	0.267
Hospitalization time		8.87 \pm 5.21	6.57 \pm 1.31	0.870

Values are given as means and standard deviation, or number of cases. ORIF: open reduction and internal fixation, n: number.

Table 2: Comparison of surgical complications between the 45 patients who had their distal fibular fracture operatively fixed with a one-third tubular plate (ORIF group) and the 42 patients who underwent percutaneous intramedullary pinning of the fibula with a rush nail (Rush group).

	ORIF group (n =45)	Rush group (n =42)	p-value
Superficial infection	12	4	0.039
Deep tissue infection	6	2	0.167
Nonunion	2	3	0.703
Malunion	0	2	0.139

Values are given as number of cases. ORIF: open reduction and internal fixation, n: number.

differences were found between the two groups as far as those complications are concerned ($\chi^2 = 1.91$, $df = 1$, $p = 0.167$ for deep infection, $\chi^2 = 0.15$, $df = 1$, $p = 0.703$ for nonunion, and $\chi^2 = 2.19$, $df = 1$, $p = 0.139$ for fracture malunion). However, in the ORIF group, there were 12 patients with a superficial infection while in the Rush group there were four and the difference was statistically significant ($\chi^2 = 4.25$, $df = 1$, $p = 0.039$). In those cases, the infection was resolved with local wound care and oral antibiotics.

Discussion

The main objective of the present study was to compare the postoperative outcomes between patients receiving percutaneous Rush pinning to ORIF for osteosynthesis of the fibula in the treatment of pilon fractures. Patients treated with ORIF appeared to have a statistically significant higher superficial infection rate. There were no differences in the nonunion, malunion, and deep infection rates between the two groups. Finally, the operating and the hospitalization time were similar.

Pilon fractures are among the most complex injuries of the ankle, and their treatment remains a challenge for the orthopedic surgeon. Fractures of the tibial plafond are usually a result of high-energy trauma and are associated with severe articular damage. These devastating injuries have been shown to have high postoperative complica-

tions while controversy still exists over their optimal treatment strategy.

There is no clear consensus in the literature regarding the optimal timing for surgery²². Some authors advocate the two-stage approach that involves the application of a temporary spanning external fixator followed by a staged internal fixation, while others support early primary ORIF¹⁶⁻¹⁸. Potential drawbacks of the two-stage approach are the longer operating times, the increased healthcare costs, and the risk of pin site infection or nonanatomic reduction⁸. Thus, many surgeons choose to proceed with definite ORIF acutely, as long as the soft-tissue envelope allows it. In our study, we only included patients treated with a single-stage ORIF.

The complexity of the fracture pattern, the severity of the articular impaction, and the presence of a concomitant fibular fracture may dictate the use of a double approach²³. Even in the presence of an adequate skin bridge between the two incisions²⁴, the absence of anteromedial muscle coverage of the distal tibia in combination with the poor regional blood supply often lead to complications of wound healing^{10,11}. In many cases in our department, the associated distal fibular fracture was stabilized percutaneously with an intramedullary rush nail to prevent those complications. Rush nail is an alternative method of fixation of fibular fractures^{25,26} that involves smaller incisions and minimal soft tissue disruption. There are, however,

concerns regarding the rigidity and the rotational stability provided by this method²⁷.

The current study compared ORIF and percutaneous Rush nailing of the associated fibular fracture. The age, gender, and mechanism of injury between the two groups were comparable, and no statistically significant differences were observed. The incidence was higher in women than men, and the average patient age was 51.33 for the ORIF group and 54.14 years for the Rush group. As far as the mechanism of injury is concerned, most of the fractures resulted from falls on level ground, followed by motor vehicle accidents and falls from height. The operating and hospitalization times were shorter for the Rush group, but the differences were not statistically significant. In particular, the mean operating time for the ORIF and the Rush group was 85.78 and 82.31 minutes, and the mean hospitalization time was 8.87 and 6.57 days, respectively. Although the hospitalization time was similar between the two groups, the Rush nail is an implant of lower cost compared to a plate construct.

In the present study, deep tissue infection was defined as an infection requiring operative intervention and intravenous antibiotics. The incidence of deep tissue infection was 13.33 % for the ORIF group and 4.76 % for the Rush group, but the difference between the groups was not statistically significant. There was, however, a statistically significant difference in the rate of superficial infection between the groups, with an incidence of 26.67 % and 9.52 % in the ORIF and Rush group, respectively. It should be noted that patients with diabetes and other causes of neurovascular insufficiency were excluded from the study. Accordingly, the lower rate of superficial infection recorded in the Rush group could be attributed to the absence of a second incision, as the Rush nail was introduced percutaneously. Nonunion occurred in two patients in the ORIF group and three patients in the Rush group and fracture malunion, defined in the present study as angulation of more than 7° in the coronal plane and more than 10° in the sagittal plane, occurred in two patients in the Rush group and there were no statistically significant differences. The similar rate of nonunion and malunion between the two groups suggests that the rush nail provides sufficient fixation stability in the associated fibular fracture.

The present study's findings have to be seen in the light of certain limitations. First, this is a retrospective study, and the data were extracted from patient charts and hospital records. Furthermore, the sample size was obtained is relatively small, but this is expected due to the infrequent nature of pilon fractures and the strict exclusion criteria applied. Also, the fixation method was based on the surgeon's preference and familiarity with the technique, which might have introduced selection bias. Finally, a longer follow-up period would be required to compare the rate of post-traumatic arthritis between the two groups, and future investigations should focus on that.

In conclusion, pilon fractures are devastating injuries with many reported postoperative complications. Percu-

aneous intramedullary rush pinning of the associated fibula fracture is a safe and effective alternative treatment option. Based on the present study results, Rush nailing is associated with a lower rate of superficial soft tissue infection and similar rates of deep infection, nonunion, and malunion compared to the conventional plate fixation.

Conflict of Interest

Authors declare no conflict of interest.

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