Feature Article

Operative Treatment for Maisonneuve Fracture of the Proximal Fibula

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ABSTRACT

This study reviewed operative treatment of Maisonneuve fracture of the fibula in 26 patients. Operative treatment consisted of restoration of the fibular length, repair of the lateral and medial ankle ligamentous structures, and placement of one or two suprasynodesmic screws. After average follow-up of 6.4 years, the clinical results were satisfactory in 23 (88.4%) patients. Operative treatment is the treatment of choice for Maisonneuve fractures, and a satisfactory outcome may be anticipated after appropriate management of any associated bony and syndesmotic injuries.

Maisonneuve fracture is a fracture of the proximal third of the fibula resulting from forced external rotation of the foot. Many authors consider Maisonneuve injury to be one of the most unstable ankle injuries. Others, however, allege this injury could be stable in internal rotation of the foot and therefore recommend conservative treatment.

This article reviews the operative treatment of 26 patients with a Maisonneuve injury and discusses the operative findings and long-term outcome of these patients.

MATERIALS AND METHODS

Twenty-six consecutive patients (16 men and 10 women) with a Maisonneuve fracture of the fibula were treated operatively between 1980 and 1995. Mean patient age was 24.7 years (range: 19-70 years).

The mechanism of injury was sports related in 9 patients. Nine patients were injured as the result of a fall, and the remaining 8 patients were injured in a motor vehicle accident. All of the fractures were closed. Twenty patients were examined and treated after an acute injury, while 6 patients were diagnosed and treated 1-3 weeks after injury because the fracture was missed during the initial examination.

All patients had ankle pain as well as swelling and tenderness on palpation of the anterior tibiofibular ligament. Diagnosis was confirmed clinically and radiographically. Anteroposterior (AP), lateral, and mortise radiographs of the ankle with the foot in 20° of internal rotation were obtained for all patients (Figure 1).

All of the patients were treated operatively. In all cases, the proximal fibular fracture was not fixed. Coexisting injuries also were repaired during surgery. Coexisting injuries are listed in Table 1. Although posterior malleolus fractures were found in 20 patients, the fractures were not fixed because they involved <25% of the articular surface.

The anteromedial capsule was plicated in all patients using mattress sutures. The deep and superficial layers of the deltoid ligament were repaired when necessary using separate sutures.

Fracture of the medial malleolus was reduced and fixed either with a wire tension band or with one or two scaphoid screws if the fragment was large enough. In all patients, reduction and stabilization of the syndesmosis was performed using one or two cortical screws. These screws were placed 3-5 cm above the syndesmosis (Figure 2). Eight fractures were fixed with two screws, and the remaining 17 fractures were fixed with one screw.

In one patient with delayed diagno-
moved in 19 patients: at 6 weeks postoperatively in 15 patients and at 3-6 months in 4 patients. In 6 patients, the suprasynodesmotic screws were in place at their latest follow-up examination. Partial weight bearing was permitted in all patients at 6 weeks postoperatively and full weight bearing was allowed at 8 weeks postoperatively.

For the purpose of this study, all patients were reexamined at 2-12 years after the initial operation (mean: 6.4 years). Each patient was interviewed and examined clinically and radiographically. Clinical criteria included the presence or absence of tenderness and swelling over the ligaments on the medial and lateral side of the ankle and also at the anterior capsule, any limitation of function or range of motion, and any residual deformity.

Radiographic examination included AP and lateral radiographs of the ankle and the proximal fibula. Radiographic criteria included the width of ankle joint space, any displacement, or any articular incongruity. Results were graded as excellent, good, fair, and poor according to DeSouza et al.\(^{8}\) (Table 2).

**RESULTS**

At the latest follow-up, 23 patients were rated an excellent or good result, two a fair result, and one a poor result. One patient with a poor result had moderate osteoarthritic changes of the ankle, while two patients with a fair result continued having mild pain, stiffness, and swelling. One of these two patients had a delayed diagnosis and treatment. In this patient, insertion of the suprasynodesmotic screw resulted in further lateral displacement of the lateral malleolus, and the screws were removed during the initial operation.

Twenty-three patients had satisfactory range of motion of the ankle and subtalar joints, equal to that of the contralateral side. Radiographs of these 23 patients showed no increase of the medial ankle joint space or of the synodesmosis. All 23 patients had recovered completely from the injury and resumed their preinjury activity level. Fibular length was restored in all but 1 patient as confirmed by the measurement of the talocrural angle.

Postoperatively, no wound-related complications occurred. There were no early or late superficial or deep infections. There was no peroneal nerve palsy. One patient developed moderate osteoarthritic changes of the ankle joint, and tibiofibular extravascular calcification occurred in two patients (Figure 3).

**DISCUSSION**

Maisonneuve fracture usually results from a forced external rotation of the foot in relation to the tibia. At the time of injury, the foot is usually in pronation, but it may be supinated.\(^{1,2,4,10}\)

In 1840, Maisonneuve\(^1\) first postulated the mechanism of this injury to the ankle in cadaveric and other experimental studies.\(^1\) He suggested forced external rotation at the ankle may result in rupture of the anterior tibiofibular ligament and subsequently fracture of the proximal fibula.

Anatomic studies have shown the syndesmotic ligaments connect the distal tibia to the distal fibula in a threedimensional way; these ligaments include the anterior tibiofibular, interosseous, posterior tibiofibular, and...
TABLE 2
Outcome Scoring System

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>No pain</td>
<td>30</td>
</tr>
<tr>
<td>No limitation of function</td>
<td>20</td>
</tr>
<tr>
<td>Excellent range of motion</td>
<td>20</td>
</tr>
<tr>
<td>No residual deformity</td>
<td>15</td>
</tr>
<tr>
<td>Normal radiographic findings</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

*Overall results were rated as excellent (90-100 points), good (80-89 points), fair (60-79 points), and poor (<59 points).

TABLE 3
Cascade of Syndesmotic and Bony Injuries Associated With a Maisonneuve Fracture of the Proximal Fibula

<table>
<thead>
<tr>
<th>Stage</th>
<th>Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rupture of the anterior tibiofibular ligament or avulsion fracture of one of its bony insertions, either one associated with rupture of the interosseous ligament and the interosseous membrane</td>
</tr>
<tr>
<td>2</td>
<td>Fracture of the posterior tibial tubercle or rupture of the posterior tibiofibular ligament</td>
</tr>
<tr>
<td>3</td>
<td>Rupture of the anteromedial joint capsule</td>
</tr>
<tr>
<td>4</td>
<td>Fracture at the proximal part of the fibula</td>
</tr>
<tr>
<td>5</td>
<td>Rupture of the deltoid ligament or fracture of the medial malleolus</td>
</tr>
</tbody>
</table>

The latter can be regarded as the fish-tailed terminal portion of the interosseous membrane that extends from just below the fibular head to just above the ankle joint. On the medial side of the ankle, the deltoid ligament is divided into the superficial and deep portion.

In the early 1950s, Bonnin7 believed that in a Maisonneuve fracture, the interosseous ligament, the interosseous membrane, and the posterior tibiofibular ligament remain intact. He classified it as a partial diastasis that is relatively stable and believed surgery was unnecessary.

In 1976, Pankovich2 described a cascade of syndesmotic and bony injuries associated with a Maisonneuve fracture of the proximal fibula and reported five stages in the development of a complete lesion (Table 3). He believed a stage 5 fracture was an absolute indication for surgery. Of the 17 patients in his series, 8 had a type 4 injury and 4 had a type 5 injury. Only two of the type 4 injuries were treated operatively, and all were associated with rupture of the anteromedial capsule. All four patients with a type 5 injury were treated operatively; these patients all regained full range of motion at the ankle and subtalar joints. Occasional mild ankle pain was their only symptom at 6-12 months postoperatively.

In cadaveric studies, Perry et al3 showed the initial stages of Bosworth fractures11 are identical to those of a Maisonneuve fracture. He recommend-
ed repair of all structures and restoration of the ankle mortise to its anatomical position by open reduction.

In a study on the operative treatment of malleolar fractures, Heim12 performed a detailed analysis of patients with a Maisonneuve fracture and concluded this entity should be discerned from other injuries. He also mentioned that rupture of the interosseous membrane was associated with high instability of the ankle.

De Souza et al8 analyzed 11 Maisonneuve fractures treated operatively and found restoration of the length of the fibula is important. They recommended a suprasynovial screw to reduce and fix the tibiofibular diastasis; however, in posterior malleolar fractures involving ≈25% of the articular surface, screw fixation was not necessary. According to these authors, a ruptured deltoid ligament may not be repaired as long as tibiofibular diastasis is anatomically reduced and rigidly fixed, and an intraoperative radiograph reveals a normal medial joint space. The results in their series were satisfactory (excellent and good) in all but 1 of the 11 patients.

According to Merrill,8 Maisonneuve fracture can be associated with partial syndesmotic diastasis. In some cases, the interosseous membrane might remain intact while the fibula rotates and can be easily disrupted by an abduction force toward the distal fibula. Eight of nine patients in his series were managed conservatively, and at an average of 25.7 months, six patients had an excellent result, two had a good result, and only one a fair result. Merrill assumed these injuries are relatively stable and can be treated nonoperatively.

Duchesneau and Fallat13 recommended operative treatment for Maisonneuve fractures to maintain reduction, stabilize the fibula, and prevent shortening and valgus talar shift, which can result in painful degenerative ankle arthritis.

Slawski and West5 described an unusual case of a Maisonneuve fracture associated with a distal fibular fracture. A complete syndesmotic disruption was found proximally and distally to the distal fibula fracture and also a complete deltoid ligament tear.

In the present series, operative findings revealed rupture of the interosseous

Figure 3: Lateral (left) and AP (right) radiographs of the patient in Figures 1 and 2 taken 2 years postoperatively. The patient refused removal of the screws. Note the tibiofibular synostosis.
ligament in all cases. This is consistent with the findings of Pankovich, who determined the interosseous ligament ruptures during the early stage of the injury. Rupture of the interosseous ligament also was documented in all cases in a recent magnetic resonance imaging (MRI) study of five acute Maisonneuve fractures. According to Lauge-Hansen, the interosseous ligament ruptures in pronation-external rotation ankle injuries.

Fracture of the posterior tibial tubercle was present in 20 patients in the present series. In all 20 patients, the fracture involved <25% of the articulating surface, and none of the fractures were fixed. This fracture was present in all type 4 and 5 fractures in Pankovich’s series and in 44% of patients in Merrill’s series.

In the present series, intraoperative findings included a ruptured anteromedial capsule in all patients as well as injury of the medial structures with either a fracture of the medial malleolus or rupture of the deltoid ligament. A limitation of the present study was the condition of interosseous membrane was checked only for a few centimeters proximal to the insertion of the suprasynodesmotic screws. Although limited, this examination revealed the presence of a tear of the interosseous membrane in 10 (39.2%) patients.

Similar findings were reported by Pankovich, who found a ruptured interosseous membrane in 6 (50%) of his 12 patients. Morris et al found a disrupted interosseous membrane in four (83%) of the five patients in their MRI study. These findings are not consistent with those of Merrill, who believes the interosseous membrane does not prevent the rotation of the fibula, which occurs during this type of injury and thus it may remain intact.

The associated rupture of the syndesmosis and the resulting instability of the ankle indicates syndesmosis screw fixation is necessary in all cases of a Maisonneuve fracture. Our current practice is to use a cortical suprasynodesmotic screw in all patients with this unstable injury.

CONCLUSION

Maisonneuve fracture has a complex pattern and is associated with various ligamentous injuries. It is an unstable ankle injury, and therefore early operative treatment is recommended in all cases with repair of coexisting injuries.

REFERENCES


EDITORIAL DISCUSSION

ORTHOPEDICS: When is nonoperative treatment indicated for Maisonneuve fractures?

Babiss et al: Maisonneuve fracture of the proximal fibula is associated with multiple ankle ligamentous injuries leading to ankle joint instability. We strongly recommend early operative treatment in all cases of a true Maisonneuve injury pattern.

ORTHOPEDICS: Should additional imaging (ie, MRI) be done to assist in deciding on definitive management of certain Maisonneuve fractures?

Babiss et al: Although MRI may detect the associated ankle ligamentous injuries of a Maisonneuve fracture, it is not cost effective and would not change the decision on definitive management of these injuries, which is early operative treatment to avoid ankle instability.