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Review

Management of Posterior Malleolar Fractures: A Systematic Review

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ABSTRACT

Posterior malleolar fractures are relatively common and usually result from rotational ankle injuries. Although treatment of associated lateral and medial structures is well established, several controversies exist in the management of posterior malleolus fractures. We performed a systematic review of the current published data with regard to the diagnosis, management, and prognosis of posterior malleolus fractures. A total of 33 studies (8 biomechanical and 25 clinical) with >950 patients were reviewed. The outcome of ankle fractures with posterior malleolar involvement was poor; however, the evidence was not enough to prove that the size of the posterior malleolus affects the outcome. Significant heterogeneity was noted in the cutoff size of the posterior malleolar fragment in determining management. The outcome was related to other factors, such as fracture displacement, congruency of the articular surface, and residual tibiotalar subluxation. Indirect evidence showed that large fracture fragments were associated with fracture dislocations and ankle instability and, thus, might require surgical fixation. We have concluded that the evidence to prove that the size of the posterior malleolar affects the outcome of ankle fractures is not enough, and the decision to treat these fractures should be determined by other factors, as stated previously.

Ankle fractures account for about 4% of all body fractures, with an annual incidence of 124 per 10,000 persons in the United Kingdom (1,2). More than one third of these fractures will involve the posterior malleolus with several variants described in published studies (1). The current published data suggest a poor outcome for ankle fractures involving the posterior malleolus (3–9).

Although the management of associated medial and lateral structures is well established, the management of the posterior malleolus fractures remains controversial. Currently, no clear consensus has been reached regarding the indications of the operative and nonoperative management of these fractures with the decision often determined by the size of the fragment.

We performed a systematic review of the English-language published data to assess the outcome of ankle fractures treated operatively and nonoperatively and involving the posterior malleolus. We also assessed the factors affecting the outcome, including the fragment size, which could guide the treating surgeon in the management of these injuries.

Materials and Methods

The review incorporated an electronic search of the Medline® database using PubMed® as the search engine (U.S. National Institutes of Health, National Library of Medicine) and Embase® (Elsevier BV, Amsterdam, The Netherlands), the Cochrane Library (John Wiley & Sons, West Sussex, UK), ProQuest® (ProQuest, Ann Arbor, MI). We included all the studies published from January 1966 to July 2014. We used the following search terms: posterior malleolar fractures, trimalleolar fractures, and Volkmann's fractures. In addition, the appropriate MeSH terms of assessment, diagnosis, evaluation, prognosis, outcomes, management, and treatment were entered and Boolean operators used. We limited our search to studies published in the English language only. Three of us (S.O., R.A., P.U.) independently evaluated the abstracts for scientific content and quality. Our inclusion criteria were any clinical and/or biomechanical studies that included posterior malleolus fractures and the evaluation, diagnosis, management, and prognosis. Once the abstract was found suitable, the study was retrieved and thoroughly evaluated. The references in the retrieved studies were manually checked to find additional relevant publications. Finally, the published proceedings of recent scientific meetings and conferences were followed, along with a manual search of current orthopedic textbooks (10,11). We excluded studies in which posterior malleolus fractures were associated

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with tibial shaft fractures, distal tibial metaphyseal fractures (pilon fractures), stress fractures, open and pathologic fractures, and case reports, technical notes, and tips.

Data Extraction

The data extracted included the demographic details of the patients, diagnosis, and treatment, including nonoperative and operative treatment. When assessing these patients, we included all the methods of nonoperative and operative treatment, irrespective of the method of treatment and fixation and the approach used. We included all the outcome measures described in the present study, including ankle osteoarthritis and objective measures such as the visual analog scale for pain (12–14), the Olerud and Mollander scores (15), the American Orthopedic Foot and Ankle Society scores (16,17), and Cedell's scores, when available (18). Finally, we addressed the prognostic implications of posterior malleolus size in the final outcome of these injuries. Data were collected on a Microsoft Office® Excel spreadsheet, edition 2013 (Microsoft, Redmond, WA).

Results

The initial search identified a total of 158 relevant citations; however, further scrutiny led to the exclusion of 125 studies (79.1%). Thus, 33 studies met the inclusion criteria, of which 8 (25.2%) were biomechanical and 25 (75.7%) were clinical studies. All the studies assessed were case series, and no randomized trials were identified during the analysis.

Biomechanical Studies

A total of 8 studies (25.2%) were identified that assessed the role of the posterior malleolus in ankle stability and joint loading. A synopsis of these studies follows. Scheidt et al (19) showed that a posterior malleolus fracture measuring ≥25% of the distal tibial articular surface led to posterior translation of the talus with an axial loads of 15 kg (150 N), and fixation of these fractures reduced posterior instability, provided the posterior inferior tibiofibular ligament was intact. However, the findings of the present study were contradicted by Raasch et al (20), who demonstrated that osteotomizing ≤40% of the posterolateral tibial margin did not significantly increase the posterior translation of the talus by a posteriorly directed force of ≤200 N, as long as the anterior inferior tibiofibular ligament and lateral malleolus were intact (20). This was further confirmed by Harper (21), who did not find a significant posterior talar translation with a posterior malleolus fracture measuring ≤50% of the distal tibial articular surface. However, in the setting of a combined disruption of the lateral and medial ligamentous structures, significant posterior translation of the talus occurred (21–23).

Papachristou et al (24), using photoelastic bone models, showed that during axial loading of the distal tibial articular surface, the load was concentrated only in the middle 50% and not in the posterior 25% of the articular surface. They thus concluded that the posterior malleolus might not be involved in load bearing. Macko et al (25) noted decreased joint contact area as the size of the posterior malleolus fracture increased to >33% of the distal tibial surface with the ankle in neutral or 10° of dorsiflexion. They concluded that this increase in focal load concentration at the tibiotalar joint might predispose to early post-traumatic degenerative changes. Hartford et al (26) agreed with these findings, reporting that an increasing posterior malleolus fracture size decreased the tibiotalar contact area, which was not affected by the integrity of the deltoid ligament. Both studies support the concept that an increasing posterior malleolus fracture size diminished the tibiotalar joint contact area (25,26). In contrast, Vrahas et al (27) noted that even after removing 40% of the posterior malleolus, the peak contact stress did not change. They thus hypothesized that even with a posterior malleolar malunion stress would not increase beyond the physiologic limits and might not contribute to the development of post-traumatic arthrosis (27).

Fitzpatrick et al (28) noted that with posterior malleolus fractures involving 50% of the articular surface, the contact stress redistributed to a more anterior and medial portion of the ankle joint. The investigators concluded that the peak stress redistribution with large posterior malleolus fractures led to abnormal loading of the tibiotalar joint and thus could lead to the development of post-traumatic ankle arthrosis (28). However, no conclusion was derived to explain why the abnormal load redistribution ensued even after adequate fracture fixation.

Summary of Biomechanical Studies

The results of the biomechanical studies have confirmed that posterior ankle stability is predominantly provided by anterior inferior tibiofibular ligament, posterior inferior tibiofibular ligament, and medial and lateral structures with little contribution from posterior malleolus. Although in itself the posterior malleolus might not be involved in significant load bearing at the tibiotalar joint, with posterior malleolus fractures, the redistribution of the load is abnormal, which might predispose the patient to the development of post-traumatic arthritis.

Clinical Studies

A total of 960 patients from 25 studies with posterior malleolar fractures were included in the present review. Of the 960 patients, 288 were female and 219 were male patients from 16 studies; however, 9 studies with 453 patients did not report the gender distribution. The mean age was 45.48 (range 13 to 84) years. In most of the studies, the diagnosis and size of the posterior malleolus fracture was made from the lateral radiograph of the ankle. In 915 patients, the posterior malleolus was a part of combined injuries (i.e., anterior, medial, lateral, and/or syndesmotic structures), and in 45 patients, it was isolated (29–31).

Diagnosis and Classification of Posterior Malleolus Fractures

Standard anteroposterior and lateral ankle radiographs were used in the diagnosis of these injuries in most of the studies. However, the reliability of using lateral radiographs in accurately determining the size of the posterior malleolus fragment has been questioned (25,32).

Haraguchi et al (33) classified posterior malleolus fractures using computed tomography into 3 types:

1. Posterolateral oblique type (67%)
2. Medial extension type (19%)
3. Small shell type (14%)

Variants of Posterior Malleolar Fracture

Two studies (17 patients) described a separate variant of the posterior malleolus fracture that involved the posteromedial distal tibial articular surface (34,35), along with medial and/or lateral injuries. All these variant fractures underwent open reduction and internal fixation using either a posterolateral or a posteromedial approach, and the investigators reported satisfactory outcomes. A recent study by Switaj et al (32) reported a 20% incidence of posterior malleolus variant (termed the "posterior pilon variant") in operatively treated ankle fractures.

Isolated Posterior Malleolus Fractures

Three separate studies involving 45 patients assessed isolated posterior malleolus fractures (29–31). All the fractures were managed conservatively, and all the studies had a relatively long follow-up period. The fragment size ranged from 3% to 47% of the distal tibial