A Narrative Review of the Classification of Posterior Pilon Variant Ankle Fractures

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INTRODUCTION:

Posterior pilon variant ankle fractures (PPVF) are a unique subtype of traumatic, posterior malleolar fractures (PMF) involving the distal aspect of the tibia. Due to the complex nature of this fracture pattern and its relatively recent definition in the field of orthopedic ankle fractures, there is much inconsistency and confusion surrounding the classification of PPVF. The current manuscript aims to narratively review the classification of PPVF.

METHODS:

A literature review of PPVF was completed on June 15, 2023. The search was conducted through PubMed and Embase, using the following search strategy: (pilon variant) OR (posterior pilon)) AND (fracture). Reference lists of relevant review articles were further reviewed for related content. There was no limitation on publishing journal or publication date. Any articles duplicated between the two databases were removed prior to screening. Studies discussing pilon ankle fractures were screened for PPVF specificity, including articles discussing classification, mechanism of injury, management, and outcomes. Titles and abstracts were screened for exclusion criteria by 3 independent reviewers, and articles passing title and abstract screening were collected as full text PDFs for further screening. Cadaveric studies, biomechanical studies, non-clinical studies, and studies not published in English were excluded.

Data extracted included: author, sample size, study type, surgical treatment method, mean follow-up time, time to union, rates of delayed union, nonunion, malunion, complications, and AOFAS score. To assess the research quality of each included study, a modified version of the Coleman Methodology Score (CMS) was applied by two independent reviewers. The scale consists of ten criteria divided into two parts, which aim to assess the overall quality of research and elimination of bias. Part A assesses study size, mean follow-up, number of surgical procedures per outcome, study design, diagnostic certainty, procedure description, and postoperative rehabilitation description and compliance. Part B assesses outcome criteria, the procedure employed for outcome assessment, and the subject selection process. Scores range from 0-100, with a score of 100 representing a study that avoids the influence of chance, bias, and confounding factors.

RESULTS SECTION:

A total of 294 potential articles were reviewed for inclusion. Ultimately, 15 articles met the inclusion criteria and were included in the review. The selection process was performed according to Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA). There was a total of 361 subjects, with a weighted mean age of 48.6 years (Range = 1-88). The mean follow-up was 22.3 months. Surgical approaches and the number of papers investigating each approach were as follows: Posterolateral (PL) alone (n = 9), posteromedial (PM) alone (n = 2), modified posteromedial (MPM) approach (n = 3), combined PM and PL (n = 5), PM and lateral approach (n = 1), posterior arthroscopic-assisted reduction internal fixation (PAARIF) (n = 1), and open fibula fracture line technique (n = 1). The reduction of bias was low across all studies, with an average Modified CMS score of 44.9.

The fracture pattern was first described in 2001 by Karachalios et. Al. as a variant of a trimalleolar ankle fracture, in which the posterior malleolus split into two fragments, a posteromedial and posterolateral fragment. The mechanism of injury involves a combination of axial and torsional forces applied to the ankle, creating a complex and often impacted fracture. Specifically, external rotation of a plantar flexed and supinated ankle more commonly resulted in a PPVF. Further research identified that the posteromedial fragment was typically the larger of the two, and if not properly reduced and fixed, could lead to significant postoperative ankle instability and talar subluxation.

Six fracture classification systems were used across 9 papers, including the AO Foundation/Orthopaedic Trauma Association (AO/OTA) (n = 5), Klammer (n = 4), Lauge Hansen (n = 2), Lei (n = 2), Zhang (n = 1), and Yu fracture classification systems (n = 1). The AO/OTA and Lauge Hansen systems were nonspecific to PPVF and therefore were not critically analyzed. The remaining four classification systems were found to be highly redundant. Criteria used to differentiate subclassifications were the location of fracture fragments, the malleolus involved in the fragment, the direction of the major fracture lines, and the number of fracture fragments. Briefly, the subclassifications from these four systems can be grouped based on the severity of the fracture pattern, with more fragments and primary fracture lines indicating a more severe fracture and outcome. No classification system adequately accounted for the surface area of the weightbearing tibial plafond in their criteria.

DISCUSSION:

PPVF are under-researched in foot and ankle orthopedics. This pattern was at first thought to be rare, but as awareness grows around the topic, the reported incidence is rising. Failure to properly fixate PPVF has been associated with healing times more than double that of direct or indirect fixation. Thus, properly differentiating PPVF from other fractures that may require conservative management is imperative. Published data shows that the mechanism of injury for PPVF is like that of rotational ankle fractures but with the addition of mild to moderate axial forces complicating the fracture pattern. PPVF do not typically present with the high energy axial forces associated with traditional pilon fractures; however, they can create similar challenges in surgical fixation and recovery. Classification of ankle fractures based on mechanism increases the risk of misdiagnosis, and more specific criteria are needed that utilize advanced imaging modalities. CT is the most reliable modality for differentiating PPVF from PMF.

Currently, no single classification system sufficiently describes PPVF while adequately differentiating them from other ankle fractures. The system proposed by Zhang et. Al. is the most comprehensive to date, but does not address the degree of impaction, discontinuity, or joint surface area involved. A true PPVF involves both the posterior and medial aspect of the tibial plafond, also referred to as the posterior and medial columns. A four-column theory has been used to describe high energy pilon ankle fractures and can be applied to PPVFs. By utilizing the four-column theory, an emphasis is put on the pilon nature of PPVF, potentially reducing the confusion between PPVF and malleolar fractures. The joint surface area involved in the fracture is another potential method for differentiating PPVF from PMF, as PPVF are associated with larger posteromedial fragments and a greater degree of articular involvement.

SIGNIFICANCE:

There is no one accepted classification system for posterior pilon variant fractures, making communication and research within the field of orthopedics difficult. More work is needed to clarify and combine features from each system to create a single comprehensive model that can guide clinical decision making and diagnoses.