

Decision Making in Acetabulum Fractures – When to Operate and When Not to?

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Abstract

The complexity of acetabulum fractures has always been challenging to the operating surgeon. In the past 50 years, following pioneering work by LeTournel and Judet, there is better clarity to the treating surgeon regarding the management of these fractures. 3D computerized tomography imaging has helped surgeons understand the fracture better and it remains the investigation of choice. Roof-arc angle measurements and the percentage of the fracture involving the superior dome are important determinants in deciding whether to operate or treat conservatively. Nonoperative management is mainly for undisplaced fractures and patients not fit for surgery. Fluoroscopy under anesthesia to check for hip joint stability and percutaneous screw fixation are new upcoming management modalities. The approaches described by LeTournel and Judet - Kocher-Langenbeck, Iliioinguinal, Iliofemoral, and extended Iliofemoral - remain the “gold standard” for appropriate fractures, but the availability of newer alternative approaches have expanded over time thereby facilitating surgeons to operate better.

Keywords: Acetabulum fracture, 3D computerized tomography, roof-arc angle, Kocher-Langenbeck approach.

What to Learn from this Article? This article gives an insight to the reader regarding the basic principles regarding the decision making to treat acetabulum fractures operatively or non-operatively. The importance of 3 dimensional CT images and usefulness of the roof arc angles in making decisions to manage acetabulum fractures has been explained. Appropriate approaches for appropriate fractures have been tabulated to guide the treating surgeon.

Introduction

“Good surgeons know how to operate, better ones when to operate, and the best when not to operate.”

This famous saying applies true for all fractures including complex ones involving the acetabulum. High-velocity road traffic accidents have frequently resulted in acetabulum fractures mostly associated with polytrauma. In the 1950s and 1960s, both operative and nonoperative treatment regimens were purported to be the best, and there was much confusion due to the unavailability of a comprehensive classification [1, 2, 3]. Landmark and meticulous work by Judet

provided clarity and gave recommendations for operative treatment based on their 10 years study following poor results from nonoperative treatment [4]. Contributions from Judet *et al* also threw light on the various indications when surgery was needed and how to manage these fractures [4, 5]. The advent of 3-dimensional computerized tomography (CT) allowed surgeons to understand the fracture pattern better and also plan the management better [5, 6]. With the advances in imaging and surgical expertise, the increase in threshold for surgeons to operate and the advances in minimally invasive fixation techniques, nonoperative treatment still forms the best treatment for particular fracture patterns and patient factors.



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Diagnosis and Imaging

No matter what method of the treatment has been selected, obtaining an excellent long-term result in the treatment of acetabulum fractures depends on restoring a congruent and stable hip joint with an anatomically reduced articular surface of the femoral head. Understanding the anatomy of the innominate bone, defining the injury through radiographic assessment, and then determining a suitable treatment plan remains of utmost importance [4, 7, 8].

In the 1960s Judet after detailed analysis of the acetabulum through dry models, advocated the need of two 45-degree oblique views in addition to the standard AP view of the pelvis to study the anatomy of the fracture better. Since then, these views are commonly used worldwide to assess any acetabulum fracture radiographically [4, 7, 8, 9]. Advances in CT technology have not only improved the information provided by the two-dimensional images but also now offer useful three-dimensional images as well as computer-generated images which allow better understanding of the fractures [10, 11, 12, 13]. C-arm image intensifier fluoroscopy has evolved nowadays and remains a method of intraoperative assessment regarding the stability of acetabular fractures [14]. As of today, the “gold standard” of imaging for the evaluation and assessment of acetabulum fractures includes plain x-rays involving a standard AP view of the pelvis, 45-degree oblique views (Judet views), and a plain CT scan with 3-dimensional images [4, 13, 14].

Nonoperative Management of Acetabulum Fractures

To attain the best results, stability and hip joint congruity must be accompanied by an anatomic (defined as <2 mm of displacement) reduction of the displaced articular surface. Therefore, an accurate reduction of the intra-articular fracture fragments is critical for a successful outcome. After proper analysis of the fracture pattern and analysis by imaging, the decision to operate or conserve depends on multiple factors [15].

As a general rule, all stable concentrically reduced acetabular fractures which do not involve the superior acetabular dome can be considered for nonoperative treatment. Nonoperative management may also be chosen for the patients with severe underlying medical problems that preclude surgery which mainly includes a small group of elderly patients. Patient-related factors such as age, preinjury activity level, functional demands, and medical comorbidities must be considered when determining whether a patient is best served by operative or nonoperative management [15, 16]. The indications for nonoperative treatment have been discussed in Table 1.

Significance of the Superior Dome of the Acetabulum

Rowe and Lowell [11] first recognized the condition of the superior dome of the acetabulum to be one of the most significant prognostic indicators of a good clinical outcome. The superior dome of the acetabulum (acetabular roof) is defined as the superior third of the weight bearing area of the acetabulum. Study of axial CT sections by Olson and Matta [10] of the superior 10 mm of the acetabular articular surface are equivalent to the weight-bearing dome region of the acetabulum. These can be useful in determining if acetabular

fracture lines involve this region. Controversy still exists regarding the exact amount of displacement that is considered acceptable when the superior dome is involved, but most authors recommend surgical intervention if displacement exceeds 2 mm [4, 10, 11].

Roof-arc Angle Measurements

Of the pioneering works done by Matta, one of the important studies involves proposing the roof-arc angle measurements in acetabulum fractures. This measurement is of utmost significance as it helps to determine if the remaining intact acetabulum is sufficient to maintain a stable and congruous relationship with the head of the femur. Using this method, operative versus nonoperative treatment can be decided. The roof-arc angle is measured on all three radiograph views without traction. The medial Roof-arc is measured on the AP view, the anterior Roof-arc is measured on the obturator oblique view, and the posterior Roof-arc is measured on the iliac oblique view. To calculate this measurement, the first line is a vertical line through the center of the femoral head and the second line is drawn from the center of the femoral head to the fracture location at the articular surface on the particular view (Fig. 1). Roof-arc measurements are not applicable to both column fractures or those with a fracture of the posterior wall. The recommendations of the angles for nonoperative treatment have been changing based on various biomechanical studies and have evolved with time. However, current recommendations are fractures with a medial roof-arc angle of greater than 45 degrees, an anterior roof-arc angle of greater than 25 degrees, and a posterior

Table 1: Acetabular fractures: Nonoperative treatment – Indications

Indications
Stable nondisplaced fractures
Stable and congruous minimally displaced fractures
Selected displaced fractures
Intact acetabulum maintains stability and congruity
Low anterior column fractures
Low transverse fractures
Low T-shaped fractures
Both-column fractures with secondary congruence
Wall fracture not compromising hip stability
Infirm patients unable to withstand surgery
Severe osteoporosis precluding fracture fixation

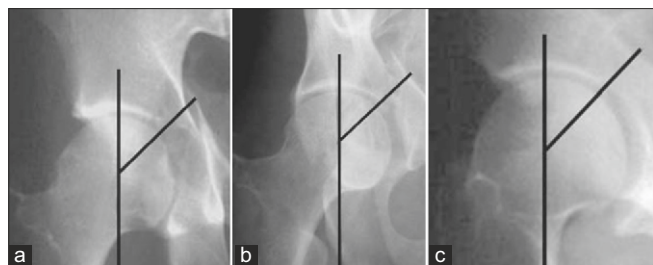


Figure 1: Roof-arc angle measurements - calculation and interpretation, (a) anteroposterior (AP), (b) obturator oblique, and (c) iliac oblique radio graphs of a transverse fracture of the acetabulum showing Roof-arcs of approximately 60 degrees each, indicative of an unstable hip joint by recommendations needing surgical fixation.

roof-arc angle of greater than 70 degrees have sufficient intact acetabulum for nonoperative management [4, 11, 13, 15, 16, 17].

However, the roof-arc angle is not without limitations. It is not applicable to both column fractures and fractures of the posterior wall [16]. Displaced both column fractures in the presence of secondary congruence especially in a young patient are amenable to nonoperative treatment. However, it must always be remembered that fractures with secondary congruence do not have as good a prognosis as those managed with anatomic reduction.

In cases of doubtful stability of the fractures, dynamic fluoroscopic stress examination with the patient under anesthesia is one proposed method of identifying fractures at risk [14]. However, the exact technique for performing this examination has not been properly defined. When in doubt, it is always safe to assume that all these fractures are unstable until proved otherwise.

Technique for Nonoperative Treatment

For those patients who meet the criteria of nonoperative management treatment mainly consists of bed rest with joint mobilization with gradual progression to full weight bearing walking. Progressive weight bearing ambulation is started at about 6-12 weeks when adequate fracture healing is seen on radiographs taken periodically [15]. Traction to the affected limb as a part of nonoperative treatment is controversial. Traction is only advised to patients with operative indications related to fracture displacement but not amenable to surgery due to their associated conditions [15, 16]. A generalised algorithm for the management of acetabulum fractures has been explained (Fig. 2).

Operative Treatment: Timing of Surgery

Classification of the fracture and subsequent pre-operative planning are important and necessary aspects of the operative treatment process. After classifying the fracture based on the radiographs and the CT scan images, the plan for fixation includes the timing of surgery and the approach to be used. In general, the surgical treatment of an acetabular fracture is not an emergency. A 3-5 days delay is commonly used to allow for evaluation of any underlying medical issues or associated injuries and for meticulous pre-operative planning [18, 19, 20].

The time to surgery has been shown to be a significant predictor of radiologic and clinical outcome and, if possible, should not be delayed beyond 10 days for associated types and 15 days for elementary fractures [21]. Recurrent hip dislocation following reduction, irreducible hip dislocation, progressive sciatic nerve deficit, associated vascular injury, open fractures, and ipsilateral femoral neck fracture are indications for emergency acetabular fracture fixation [22].

Surgical Approach

Selection of the appropriate approach is one of the most important aspects of the pre-operative planning for acetabulum fracture fixation. Fracture type, the elapsed time from injury to operative intervention, and the magnitude and location of maximal fracture displacement are the main determinants in the decision making [4, 17, 18]. The mainstay surgical approaches to the acetabulum are those described by Judet *et al.*: the Kocher-Langenbeck, the ilioinguinal, the iliofemoral, and the extended iliofemoral [4, 18]. The first three approaches provide direct access to only one column of the acetabulum (posterior for Kocher-Langenbeck; anterior for ilioinguinal and iliofemoral) and require indirect manipulation for reduction of the fracture lines that traverse the opposite column. A sequential approach is then added if the single approach proves insufficient to accomplish the reduction of the opposite column. The extended iliofemoral approach affords the opportunity for almost complete direct access to all aspects of the acetabulum and is mostly used for delayed treatment of an associated fracture type [20, 21, 22]. However, alternative approaches have been proposed and these include the modified Gibson approach, the modified Stoppa approach, the trochanteric flip osteotomy and a simultaneous combination of the standard anterior and posterior approaches [22]. Appropriate approaches for the particular fracture types have been described below in Table 2.

Discussion and Summary

Although significant strides have been made in fracture fixation, nowadays, acetabular fracture fixation surgery still remains an extensive surgery with a significant potential complication rate [1, 2, 3, 4, 5, 17, 22]. The results published by Judet *et al* in 1993 remain the “gold standard” in the management of acetabulum fractures [4].

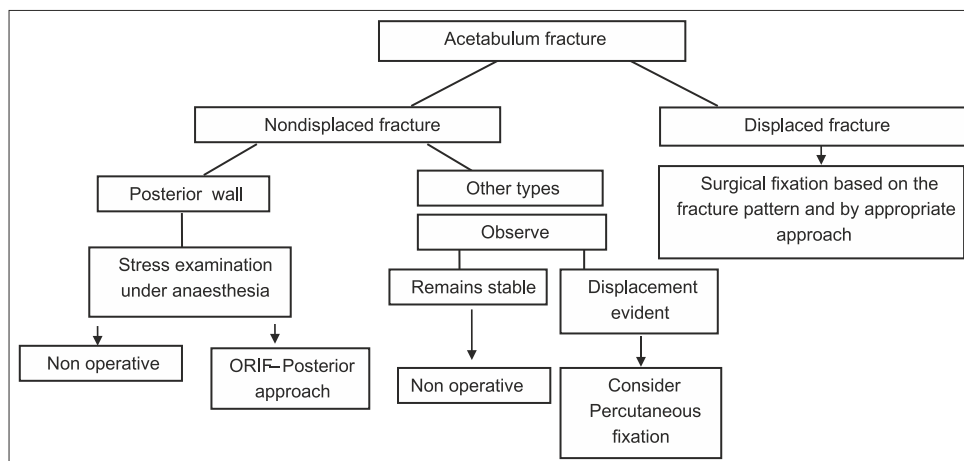


Figure 2: Algorithm for decision making in the management of acetabulum fractures.

Table 2: Standard surgical approaches for each particular fracture pattern. Fracture patterns in bold indicate the most appropriate indication to use the corresponding approach

Surgical approach	Fracture pattern
Kocher-Langenbeck approach	Posterior wall
	Posterior column
	Posterior column and wall
	Transverse fracture and transverse-infratectal
Ilioinguinal approach	T-type fracture and T-type infratectal
	Anterior wall
	Anterior column
	Anterior and posterior hemitransverse
Iliofemoral approach	Both column
	Anterior wall
Extended iliofemoral approach	Anterior column
	T-shaped transtectal
	Transverse transtectal
	Both column

As per the current guidelines in the management of acetabulum fractures to make a decision, the following are recommended by the authors:

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Good sound knowledge of the anatomy of the innominate bone, sharp and meticulous surgical skills, proper pre-operative planning, and performing surgery on patients with the right indications are factors which have stood the test of time and when practiced give good results to the patient and the operating surgeon.

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