Acetabular fractures, anatomy and implications for treatment

Timothy A Coughlin
Faiz S Shivji
Conal Quah
Daren P Forward

Abstract

Acetabular fractures are relatively uncommon and their definitive treatment tends to be focused on specialist major trauma centres. This can make both accurate diagnosis and management challenging, particularly in hospitals where they are rarely seen. Contemporary management of these injuries owes a lot to the work of Judet and Letournel undertaken in the 1970s. The key to understanding these injuries is to know the embryology and development of the pelvis and then be able to appreciate its three-dimensional structure from two-dimensional X-rays. This can then be overlaid with the Judet classification and the action of force vectors encountered in various mechanisms of injury. It is also important to realise the ageing demographics of this group of patients and the complexities this adds to classification and ultimately treatment. Finally, the presence of an acetabular fracture is often seen in association with a number of other injuries. It is imperative that these are appropriately and contemporaneously diagnosed so that a comprehensive management plan may be instituted to give the best outcomes. However, even with optimal management the prognosis is guarded with a majority of patients suffering some degree of functional loss and this must be made clear to the patient from the outset.

Keywords acetabulum; column; fracture; Judet; Letournel; pelvis; wall

Introduction

Although uncommon, acetabular fractures are complex injuries which pose challenging questions for clinicians when deciding the optimal management strategy. This is due to the difficulty in characterizing the fracture configuration and the intra-articular nature of the fracture producing a significant risk of post-traumatic arthritis. The diagnosis, classification, and treatment of acetabular fractures was pioneered by Judet and Letournel in the 1970s, and since then, the management has evolved with the use of detailed imaging of fractures via computed tomography and improvements in osteosynthesis and hip arthroplasty. As with any fracture, an understanding of the anatomy, deforming forces, surgical approaches, and patient factors are required to avoid poor outcomes.

Timothy A Coughlin *BMBS BMedSci MRCS Specialist Registrar, Trauma & Orthopaedics, Queen's Medical Centre, Nottingham University Hospitals NHS Trust, UK. Conflicts of interest: none declared.*

Faiz S Shivji *BMBS BMedSci MRCS Specialist Registrar, Trauma & Orthopaedics, Queen's Medical Centre, Nottingham University Hospitals NHS Trust, UK. Conflicts of interest: none declared.*

Conal Quah *MBChB FRCS Cavendish Hip Fellow, Sheffield Teaching Hospitals NHS Trust, UK. Conflicts of interest: none declared.*

Daren P Forward *MA FRCS DM Consultant Orthopaedic Trauma Surgeon, Queen's Medical Centre, Nottingham University Hospitals NHS Trust, UK. Conflicts of interest: none declared.*

Anatomy

Embryology

The prenatal development of the pelvic bone and acetabulum commences during the embryonic phase between weeks 2 and 8 of gestation. The pelvis and hip joint differentiate from the same primitive mesenchymal cells. The iliac, ischial and pubic cartilages fuse together to ultimately form the acetabulum. By approximately the 6th week of gestation, features of the hip joint may be visible and by the 11th week the hip joint is fully formed.[1,2]

Enchondral ossification of the ilium, ischium and pubis occurs during the fetal phase from 8 weeks up until birth. During this phase, the epiphyseal centres become clearly defined. The triradiate cartilage is a triflanged structure formed by the junction between the physeal plates of the ilium, ischium and pubis. The hip joint increases in diameter during development by interstitial growth within the triradiate cartilage. The concave shape of the acetabulum is determined by the presence of a spherical femoral head.[1,2]

Columns and walls

The acetabulum is a deep cup-shaped hemispherical structure which is directed forward, lateralward and downward. It is formed superiorly by the ilium, medially by the pubis and laterally and inferiorly by the ischium. Letournel and Judet described the two-column theory.[3] The acetabulum is supported by two bony columns (anterior and posterior) to form an 'inverted Y' and is connected to the sacrum through sciatic buttress. The anterior column is comprised of the anterior ilium, anterior wall and dome, iliopectinate eminence and lateral superior pubic ramus. The posterior column is comprised of the greater and lesser sciatic notches, ischial tuberosity, posterior wall and dome and quadrilateral surface.

Vascular anatomy

The arterial supply to the acetabulum is derived from branches of the obturator artery, superior gluteal artery and inferior gluteal artery. The acetabular branch of the obturator artery supplies the pelvic surface of the acetabulum through the acetabular notch. Deep branches of the superior gluteal artery and inferior gluteal artery supply the superior and postero-inferior region of the acetabulum respectively.[4]

Epidemiology

Acetabular fractures have a bimodal age distribution, affecting young patients who have sustained a high-energy mechanism of injury such as fall from height or road traffic accident (RTA), and older patients who have fallen from standing and fractured

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through osteopenic bone. The incidence of these fractures in young people is 3.3/100,000 persons/year, compared with 23/100,000 persons/year in the elderly, reflecting the increased activity levels seen in an older, but ever healthier population.[5] The elderly population represent the fastest growing age group affected by pelvic trauma. The overall gender distribution is roughly 75% male and 25% female.

The most common mechanism of injury varies within the literature, with falls from standing height ranging from 27% to 49% of all fractures, RTAs 5%–30%, and falls from height responsible for 13–16%.[5] There is evidence that the population is changing with a downward trend in the admitting Injury Severity Score (ISS) of patients with acetabular fractures reflecting the lower energy injuries seen in more elderly patients. Interestingly this is associated with a fall in mortality indicating healthier elderly patients have a better prognosis than one might expect.

Force vectors

Acetabular fractures tend to present with a number of patterns which are influenced by a number of factors. The position of the hip and femoral head at the moment of injury is well documented as one of the key determinants. There are three broad mechanisms which will predict the five simple fracture patterns described by the Judet and Letournel classification (Figure 1).

The combined fracture patterns are usually the result of a combination of force patterns which will often occur in polytrauma, or where a rotatory force is applied to the femoral head rather than an angular one.

As well as the vector of the force the absolute size of the force will affect the pattern seen with the column fractures requiring greater force than wall fractures. The quality of the patients' bone will have an impact with poorer bone needing less force to result in the same injury.

It has also been more recently shown that anatomical variation in acetabular version will have an effect on fracture pattern. For example increasing acetabular retroversion may increase the likelihood of a wall fracture rather than a column fracture as shown in Figure 2.

Classification

Judet and Letournel

The Judet and Letournel classification remains the most commonly used classification for both research and clinical classification. It was originally published in the American volume of the *Journal of Bone and Joint Surgery*,[3] slightly modified by Letournel.[3] It was designed prior to the development of CT scanning (the first clinical CT scanners were installed in 1974) and hence is based on anteroposterior (AP) and two oblique (Judet) X-rays. Figure 3 below shows the position of the anterior and posterior columns and walls seen on a lateral, obturator and iliac oblique views.

The classification describes ten fracture patterns, five of which are considered simple and five combined. Figure 4 shows

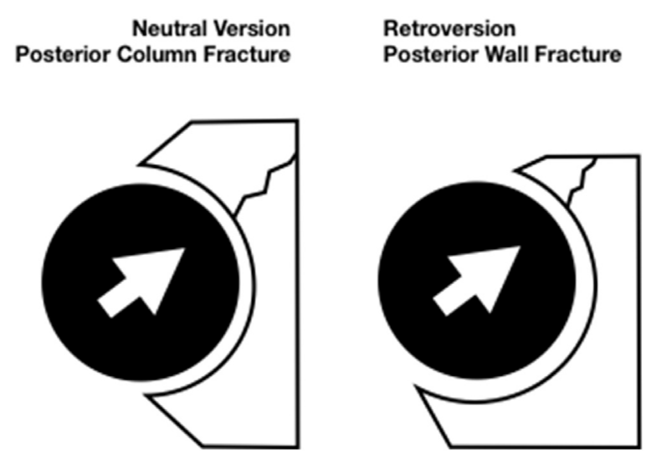

Figure 2 Effect of variations in acetabular anatomy on fracture pattern with the same force vector applied.

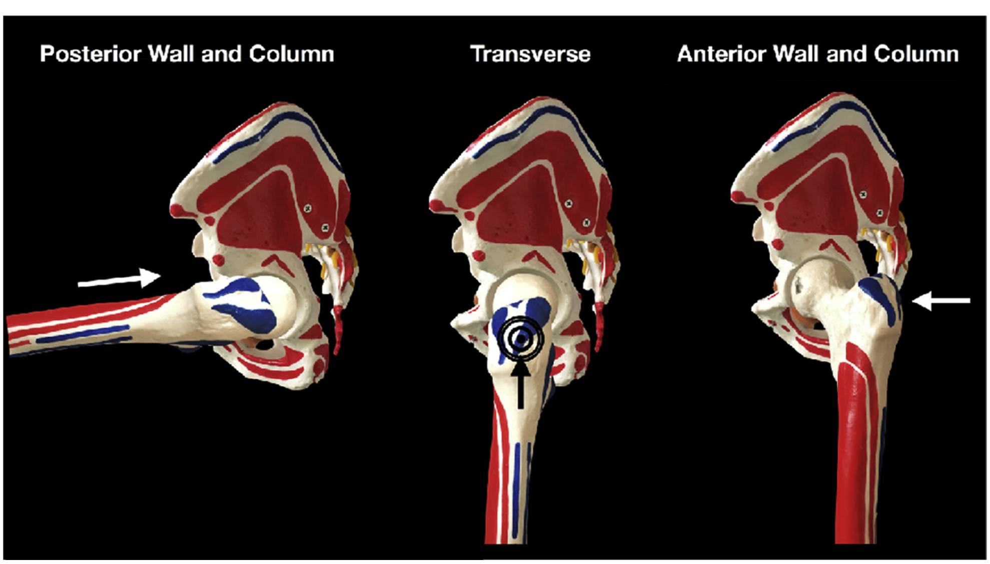

Figure 1 Force vectors leading to the simple fracture classification of the Judet and Letournel classification.

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