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Lateral compression fracture of the pelvis represents a heterogeneous group of complex 3D patterns of displacement

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Summary Although clinical and radiological criteria exist to direct the non-operative and operative treatment of other types of pelvic injuries, none exist for lateral compression (LC) fractures. The purpose of this study is to describe the patterns of injury in LC fractures through quantitative 3D radiographic analysis. It is hypothesised that LC fractures represent a spectrum of injuries with a combination of translational and rotational displacements. CT data from 60 patients with unilateral lateral compression fractures were obtained. Quantification of translations and rotations of the fractures was performed using 3D visualisation software. Fractures initially diagnosed as LC actually represent a spectrum of displacement patterns, ranging from a minimally displaced hemipelvis to complex combinations of displacements. Fractures were grouped based on pattern of rotation and translation into 5 distinct groups. 3D analysis of displacement patterns demonstrated a complexity in LC fractures which may explain the variations seen in outcomes associated with this injury.

Introduction

Historically, pelvic fractures have been classified based on the correlation between pelvic stability and the mechanism of injury, as proposed by Pennal and modified by Tile.[18,20] Young and Burgess[23]

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refined this concept stating that pelvic stability can be judged by fracture pattern, direction of the force of injury, and by knowledge of pelvic ligamentous anatomy. Their classification includes anterior pelvic compression, lateral compression, vertical shear and combinations thereof, subclassifying the LC fractures into types I, II and III (windswept). The OA/OTA classification of pelvic fractures is based on Tile's classification. Bucholz described an anatomical classification based on the degree of posterior injury to the pelvic ring and an assessment of stability, but the system contained only 3 groupings. In contrast, Letournel classified pelvic ring injuries simply according to site of injury (anterior or posterior). Classification systems have been developed to provide guidance to orthopaedic surgeons in directing appropriate fracture management,[4,17,18,20,21] however better understanding of patterns of pelvic injury is needed in order to optimise treatment strategies.[10]

Lateral compression (LC) pelvic injuries constitute a diverse group of fracture-dislocations that occur after application of laterally directed forces to the pelvis.[2,4,5] LC fractures account for more than 50% of all pelvic injuries in most series[20] and are most commonly caused by side impacts.[9,13,20] This lateral impact mechanism results in fractures which are normally classified as rotationally unstable but vertically stable (OTA Type B2) injuries.[17] These injuries usually include a compression fracture of the posterior pelvic ring with impaction of either the sacrum or the sacroiliac (SI) joint, and an ipsilateral or contralateral anterior pelvic ring disruption.[15,16,20]

Presently, while clear clinical and radiological criteria exist to direct the non-operative and operative treatment of other types of pelvic injuries such as open book injury and specific subtypes of LC fractures (crescent, posterior locked and anterior locked pelvis), no such criteria exist for the majority of LC fractures.[18,20] Anecdotally, some surgeons believe the majority of patients with LC fractures do well with non-operative treatment.[16] Recent studies however, have shown a correlation between residual displacement, decreased function and increased pain in these injuries, indicating that a subgroup of patients with LC fractures may benefit from an improved outcome with operative treatment.[1,14,15] More recently, some orthopaedic trauma surgeons have advocated fixation (internal and/or external) of some LC injuries to improve patient comfort and to allow for earlier mobilisation.[19] According to the current standard of care, the decision to offer operative stabilisation to patients with LC fractures is based on a clinical impression of pelvic mobility, leg length discrepancy, pain and a qualitative assessment of the severity of radiographic displacement.[1,11] Current stability is only defined clinically by physically evaluating the amount of motion of the affected hemipelvis under sedation or anaesthesia. Due to difficulties quantifying pelvic displacement and instability outside the operating theatre, the indications for non-operative and operative treatment of LC fractures remain unclear.

In order to identify which patients with LC injuries may benefit from surgery, it is necessary to develop a better understanding of the spectrum of pelvic stability associated with LC fracture. The aim of this study was to describe the patterns of injury to the pelvis in LC type fractures through quantitative 3D radiographic analysis. A more detailed analysis of LC type displacement patterns will elucidate the indicators for operative treatment in this fracture group. We hypothesise that LC fractures represent a spectrum of injury with a complex combination of translational and rotational displacement patterns.

This study is phase one of a larger study for the evaluation of lateral compression fractures of the pelvis, which will attempt to prospectively relate 3D displacement patterns with assessments of pelvic biomechanical stability and more comprehensive patient outcome data. This additional information is required to determine the ultimate clinical relevance of our findings. Identifying the complex patterns of displacements and rotation associated with LC fractures is the first step in this process.

Materials and methods

Patient data and 3D analysis

Sixty patients (from 2002 to 2004) were identified as having a unilateral lateral compression fracture of the pelvis (47 yrs $\pm$ 19, 27 males, 33 females). The diagnosis of LC fracture was established by two pelvic and acetabular surgeons using normal clinical methods including clinical and radiographic criteria. Based on plain film and CT scan, evidence of sacral impaction and/or whether anterior ramus fracture was present.[23] The Tile classification was used where lateral compression fractures (type B2) are considered rotationally unstable and vertically stable. All patients had a relevant mechanism of lateral compression and presented with pain or horizontal instability on physical examination. We included only isolated, unilateral pelvic fractures without acetabular involvement and with a pretreatment CT scan.

A 3D reconstruction of each pelvis was created from the pretreatment CT data using commercially