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Editorial

What is new in acetabular fracture fixation?

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Acetabular fracture surgery is a subspeciality of orthopaedic trauma that has recently faced a substantial evolution especially after the pioneering work of Emil Letoutnel in early 1960s. Over the last years an increased number of various new concepts relevant to every aspect of acetabular fracture surgery have been introduced. In this article we attempt to summarise the recent knowledge in acetabular fracture surgery in relation to epidemiology, diagnosis, training/teaching, surgical approaches, reduction techniques, implants, rehabilitation and outcomes as this has been presented in the literature over the last five years (2010–2015).

Epidemiology

The changing epidemiology of acetabular fractures is not a new knowledge. Recently, two population subgroups have gained particular attention; the elderly and the children. It is well known that the elderly patients with acetabular fractures constitute the fastest growing subpopulation of pelvic trauma [1]. Data from the German Pelvic Registry confirm the shift of acetabular fractures age distribution towards elderly people with peak ages between 61 and 70 years [2]. The same dataset also reveals that the fracture types involving the anterior wall are becoming more frequent in patients above the 60 years of age whilst the fractures involving the posterior wall are increased in younger patients. In the same line, an epidemiological study of acetabular fractures in elderly patients by Ferguson et al. [3] reported an incidence of 24% of displaced fractures.

Acetabular fractures in children are an entity not very well studied in the contemporary orthopaedic literature. The most recent epidemiological data come from the German Pelvic Trauma Registry [4]. The incidence of the reported pelvic and acetabular fractures in children has been estimated to be 2.1% (153/7360). From these 153 children only 15 (9.8%) were found to have an injury to their acetabulum. Thirty six percent of these children had multiple injuries whilst the mean ISS reported in the above cohort of patients was 16.3 ($\pm$11.93). The great range of ISS denotes the great variability of the data and the heterogeneous population included in this study. Another point that merits attention is the fact that only 6 out of 15 patients had any follow up which was ranging between 2 and 11 years. The above underpins one of the basic characteristics of paediatric patients with pelvic and acetabular injuries which is the absence of sufficient long term follow up. We have recently reported [5] in a more homogenous paediatric population including all the polytrauma children (ISS $>$ 16) admitted to our institution over a period of ten years with pelvic and acetabular injuries. Amongst these severely injured children (mean ISS: 31.4, range 16–57) only 2 (1%) had suffered an acetabular fracture. The limitation of the study in relation to the diagnosis of acetabular fractures was the fact that very few of these patients had an MRI of the pelvis and acetabulum, which raises the question of under-diagnosis of these injuries in children.

Teaching–training

The role of education in improving trauma care has been the focus of recent research in trauma surgery [6]. Training and teaching of young orthopaedic surgeons to acetabular fracture surgery is a field that has always been challenging due to the anatomic complexity of the pelvis and the difficulties in understanding the three dimensional anatomy of the area. Ly et al. [7] in a study testing the efficacy of a step-wise approach in classifying acetabular fractures using traditional plain radiographs found that the residents' ability to correctly classify the fractures was modestly increased by the use of an algorithm. Along with assessing the way of looking into the classification of acetabular fractures using plain radiographs, the utility of 2D and 3D CT reconstructions is being revisited. In a multicenter study from Norway [8] the value of improving the inter- and intra-observer reliability of the oblique Judet view of the acetabulum in addition to the 2D and 3D CT scans was tested. The authors questioned the routine use of the oblique views showing that there was no improvement in the reliability of the classification with the addition of these views. Additionally Garrett et al. [9] confirmed the effectiveness of 3D CT reconstructions as an educational tool in acetabular fracture surgery. Not surprisingly, the use of 3D CT scans is more useful for junior trainees compared to more experienced surgeons.

The role of three-dimensional technology in understanding the acetabular fracture complexity has also been evaluated. Hansen et al. [10] found that the "Hands-On" anatomic teaching pelvic model proved to be more efficacious compared to informational teaching sheets in classification of acetabular fractures. Fornaro et al. [11] created a patient-specific model based on preoperative

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CT scans. Using interactive virtual fracture reduction and fixation the authors concluded that their model could be useful in preoperative planning and creation of bespoke patient-specific implants based on the virtually reduced pelvis. The first step of the "Visual overlay" technique i.e. tracing of fracture fragments on radiographs in an associated both column acetabulum fracture has been tested by Pahuta et al. [12]. The residents allocated to the virtual group had a better performance compared to the residents allocated to sawbones and those of the control group. The 3D printing technology in creating a model of the fractured acetabulum and using it for planning and preoperative/intra-operative teaching was assessed by Nikura et al. [13]. The authors support that their tactile navigation tool was useful in various aspects of planning, education and operative simulation. Despite the aforementioned recent advances, three-dimensional technology is still in its infancy and has not yet been widely implemented in acetabular surgery.

Surgical approaches

Various new surgical approaches in acetabular fracture surgery have been developed in the recent past and supplement the armamentarium of the acetabular fracture surgeon with additional options in approaching specific fracture patterns. At the same time numerous modifications of existing approaches have lately been developed [14–16]. The surgical hip dislocation as described by Ganz et al. [17] constitutes a major advance in this field. Despite its wide acceptance, there is only four case series evaluating its use in acetabular fracture surgery. Notably, only one of this series comes from a centre different from the one that this approach was originally described. In the largest series of patients treated in a different from the original centre, Masse et al. [18] published their results of 31 fractures treated using the surgical hip dislocation with a mean follow up of 24 months. The authors report good clinical and radiological outcomes but they emphasise the need of multicenter trials in order to confirm that the initial promising results can be replicated. An important advance in paediatric acetabular fracture surgery comes from a study by Podeszwa et al. [19]. The authors describe the surgical hip dislocation in 11 children with intra-articular hip pathology (entrapped labrum and osteochondral fragments) for first time. They conclude that this is a safe and effective method with no osteonecrosis of the femoral head noted at the final follow up of the patients (24.5 months).

The anterior intrapelvic approach for fixation of acetabular fractures in not new but our knowledge and understanding of its advances and limitations is continuously evolving. Despite the fact that it is used from an increased number of pelvic and acetabular surgeons and its indications are currently expanding to almost all of the anteriorly based acetabular fractures, it is not meant to substitute the classic approaches but rather to be a useful adjunct to address specific fracture patterns [20]. The description of safe zones of implant placement and the techniques/instruments/implants that have been developed specifically in relation to this approach represent the major contemporary progresses noted. The newly introduced Pararectus approach [21,22] seems promising in addressing specific fracture pathologies such as geriatric fractures but more data from clinical studies are needed to conclude on its safety and efficacy [23].

Reduction techniques

Recent advances related to reduction techniques in acetabular fractures have been described in relation to the manipulation manoeuvres, reduction tools and navigation-assisted reduction. The direct manipulation of the posterior column through an anterior intrapelvic approach as described by Kistler and Sagi [24] is an example of new technique developed in conjunction with this approach that allows for a more precise reduction and fixation.

The reduction of the anteriomedial dome impaction fracture (the fracture that is created the so called "gull-wing sign" in plain radiographs) has recently gained attention mainly due to the fact that its manipulation and stabilisation is difficult and its presence is linked to poor results. It is noteworthy that the first concise description of the technique was only recently published by Scolaro and Routt [25]. The authors provide a detailed description of the manipulation of the fracture via a cortical window of the inner iliac fossa through an ilioinguinal approach and fixation without using a graft. Zhuang et al. [26] described the same technique in 14 patients with the utilisation of autologous bone graft to support the reduced osteoarticular dome fragment. The direct manipulation of the articular dome fragment via the anterior intrapelvic approach after mobilisation of the quadrilateral plate has also been recently depicted [27]. Laflamme and Hebert-Davies [28] have also reported favourable results of this technique using calcium phosphate in some of their cases for grafting the subarticular void.

Newer instruments that aid in reduction of acetabular fractures have also been introduced to everyday practice. Some of the most important include the radiolucent retractors (with incorporated suction and light lamps), handles for plate insertion, angled ball spike pushers and in situ benders.

Navigation technology has gained some popularity over the last years and various experimental and clinical studies have been published. In both cadaveric [29] and synthetic pelvices with prefabricated soft tissue envelope [30] the superiority of 3D navigation has been claimed. The percutaneous navigation technique in acetabular surgery has been described in detail [31,32]. Nevertheless to the best of our knowledge there are only a few clinical studies directly comparing conventional fluoroscopy to 3D image-based navigation. Oberst et al. [33] analysed the radiologic (postoperative plain radiographs and CT scans) of 68 patients with acetabular fractures and concluded that the quality of the postoperative reduction was better in the patients that the 3D image-based navigation was used. Consequently, the authors supported the use of navigation technology in the management of displaced acetabular fractures. Wong et al. [34] reported on 162 percutaneously inserted screws for pelvic and acetabular reconstruction. They concluded that navigation is useful and can promote accurate insertion of screws pointing out that constant vigilance is required to avoid misplacement.

Implants

New implants that have been lately introduced in the acetabular surgery are mainly the plates specifically designed for buttressing and fixation of the quadrilateral plate. These plates can be inserted supra- or infra-pectineally, are precontoured but flexible enough to allow adjustment to the fracture configuration and pelvic morphology. Their use is still evolving and up to date there are no studies in the English literature reporting on the relevant outcomes or comparing them with more traditional methods of quadrilateral plate fixation. In a recent retrospective review of our practice [35] we have reported good clinical and radiological outcomes by buttressing the quadrilateral plate with traditional plating techniques though an ilioinguinal approach. We claim that this surgical tactic still remains a valid method of fixation in acetabular surgery and that additional high quality studies are needed to compare the efficiency of this method to new surgical approaches and fixation implants.