The T-Shaped Fractures of the Acetabulum

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Introduction

The T-shaped pelvic fracture represents from 3%-12% 1 of all acetabulum fractures. It is defined as a transverse acetabulum fracture in combination with a vertical fracture that divides the posterior column from the anterior column (Figure 1). Although the T-type fracture affects both columns, it differs by definition from a fracture of both columns in that part of the acetabulum articular surface still remains stably attached to the iliac pelvic ring.

Depending on the height of the transverse fracture line, transtectal fractures (approximately 27%), yuxtatectal fractures (approximately 45%) and infratectal fractures are distinguished (approximately 28%). In most of the cases the vertical fracture goes through obturator foramen (approximately 62%) and only in some occasions anteriorly through the pubic inferior branch (approximately 18%), or posteriorly through the isquiatic tuberosity (approximately 20%) [1].

The management of acetabular fractures has improved greatly over the last 30 years [2]. Non-operative management was preferred by most orthopaedic surgeons until Judet et al. published their paper in 1964 which led to a better understanding of the different types of acetabular fractures [3].

A satisfactory result of the treatment of acetabular fractures requires anatomic reduction, stable internal fixation and early mobilization. The treatment of choice for acetabular fractures with an incongruity greater than 3 mm is open reduction and internal fixation [4].

Letournel reported good outcomes in 75% of operated fractures of the acetabulum observed for 2-21 years. This figure increased to nearly 90% of good or excellent results when the initial reduction was anatomic and maintained, but was only 55% when reduction was imperfect. Procedures using plates, lag screws or both have been advocated for fixation of anterior and posterior column fractures. Optimal position and amount of internal fixation and the required surgical approach or approaches for both column fractures also are debated [5-8].

Despite the requirement of regaining and maintaining anatomic reduction is essential for the success of the procedure, few studies have been reported to evaluate techniques of fixation. No biomechanical studies in vivo have been carried out about the T-type acetabular fracture. In 1995 reports over cadaveric models the results in relation to stability of diverse types of internal fixation needing anterior, posterior or combined surgical approaches for the T-shaped acetabular fracture [4]. The evaluation regarding with did not show differences statistically significant. The anterior column plate provided the highest degree of added stability for the anterior column fracture line, although differences were not statistically significant. Same was found for the posterior column fracture line with the posterior column plate. Each plate or combination stabilized the inferior fracture line similarly. This study attempted to evaluate an unstable T-type acetabular fracture in a physiologic manner. The authors performed a load of approximately 10% of bodyweight. This is the load that might be anticipated during rehabilitation in the hip of a patient after open fixation of an acetabulum fracture. The displacements evaluated did not differ between the three types of fixation at each of the 3 fracture sites. These results suggest that either an anterior or posterior plate provides equivalent stability compared with a combination of anterior and posterior plates. Perhaps the fracture line that includes more of the articular surface or most displaced should influence what type of plate is used, if anterior or posterior. Therefore, the approach the surgeon is most familiar with should influence the decision to use anterior or posterior plate.

We have to take into account that operative procedures carry risks of infection, deep vein thrombosis, nerve palsy, and heterotopic ossification among others. Specific problems associated with internal fixation include intraarticular penetration of screws or loss of fixation, which may lead to the rapid development of osteoarthritis or chondrolysis [9,10].

Treatments

Accuracy of the fracture reduction may be considered as the main problem of reduction of a displaced T-shaped fracture of the acetabulum. To show that approaching the pubo-acetabular fragment to reconstruct the pelvic brim is important for the reduction theses kind of fractures

Figure 1: T-Type fracture of the acetabulum.
The analyzed three types of fixation for T-shaped acetabulum fractures: double column reconstruction plates, anterior column plate combined with posterior column screws, and anterior column plate combined with quadrilateral area screws were chosen for evaluation [12]. The fixation systems were assessed through effective stiffness levels, stress distributions, force transfers, and displacements along the fracture lines. Authors concluded that all three fixation systems can be used to obtain effective functional outcomes but the third one was the optimal method for T-shaped acetabular fracture.

A new clamp that can successfully pull the posterior column back to the anterior column and firmly maintain the reduction was introduced recently to treat three cases of T-shaped acetabular fractures [13]. This clamp's aiming plate can facilitate the insertion of long lag screws and the open reduction and internal fixation of acetabular fractures.

The study described that factors related to a poor outcome were age >40 years, development of avascular necrosis, T-shaped fractures and more of >3 mm residual displacement [12].

In relation to the surgical access, the Kocher-Langebeck approach is used for most of the T-shaped fractures [14,15]. Prone patient positioning on a table is preferred. The anterior column fracture is exposed with longitudinal traction and retraction of the posterior column. As for a transverse fracture the anterior column is reducted with a clamp and fixed with a lag screw. The traction is released, the femoral head is repositioned, and the posterior column is reduced. Palpation of the quadrilateral surface is used to confirm reduction surface. A lag screw is inserted across the posterior column. In order to complete the construct a plate is placed on the retroacetabular surface. When these steps do not make possible the reduction of the anterior column, the posterior column is reduced and fixed, and reposition of the patient would be required for a second-stage anterior approach (ilioinguinal approach) taking into account that the posterior column. A combined approach might be necessary with difficult reduction. Contraindications were fractures of more than 15 days, abdominal problems and suprapubic catheters [1].

The advantages and disadvantages described for each type of approach were:

**Surgical hip dislocation approach:**

- Intermuscular approach low invasive.
- Direct view of articular surface.
- Approach of the superior aspect of the acetabulum.
- Approach of the entire posterior column.
- Additional approach of the anterior column.
- Additional approach of the anterior wall.
- Possibility of treatment of injuries of the femoral head.
- Possibility of primary total hip replacement by the same approach.
- Direct visual exclusion of an intraarticular torsion.

**Disadvantages**

- Only it is possible to achieve a partial reduction of the anterior column.
- A greater trochanter osteotomy is needed.
- A minimum risk of avascular femoral head necrosis exists.

**Stoppa approach**

**Advantages**

- Earlier rehabilitation.
- Surgical requirement of this approach is relatively easy and secure.
- Less invasive than the classic ilioinguinal approach or than the extended iliofemoral approach.
- Easy closing of the wound.
- Very reduced tendency to develop heterotropic ossifications.
- There is no risk of damaging the sciatic nerve or the lateral femoral cutaneous nerve.
- The risk of damaging the great iliac vessels is low.
- Change to a classic ilioinguinal approach.
- Low bleeding.

**Disadvantages**

- The internal fixation may be difficult.
- It is only possible to achieve a limited reduction of the posterior column.
| Authors              | Year | Patients | Follow-up period | Type of Fracture | Treatment | Surgical approach | Methods of evaluation | Results                                                                 | Complications |
|---------------------|------|----------|------------------|------------------|-----------|-------------------|-----------------------|--------------------------------------------------------------------------|---------------|
| Wang et al. [13]    | 2015 | 3 patients | Not specified    | T-type fractures | Plate and screws. | Technical evaluation of new clamp Simple X-ray | Good reduction and stable fixation | None                                                                     |
| Fan et al.          | 2015 | 3 pelvic model | Not specified | T-type fracture | Double column reconstruction plates, anterior column plate combined with posterior column screws, and anterior column plate combined with quadrilateral area screws (P+QS) | None | Biomechanical evaluation in experimental models | Effective functional outcomes. The third fixation system was the optimal method: anterior column plate combined with quadrilateral area screws | None |
| Bath et al.         | 2014 | 5 patients | 2-5 years        | T-type fracture | Plate and screws. | Simple X-ray evaluation and Merle functional score | 3 fair and 2 poor results | Not specified |
| Lao et al. [21]     | 2011 | Case report | 2 years.         | Anterior hip subluxation following fixation of a T-shaped acetabular fracture | Plate and screws. | Ilioischiatric screw and an AO reconstruction plate in neutralization. | Extended iliofemoral approach Simple X-ray evaluation and CT | Fracture union 7 months after the initial accident as well as absence of a joint congruence defect and heterotopic ossifications. | Lateral subluxation. post-traumatic osteoarthritis 2 years after the initial accident. |
| Tannast et al. [1]  | 2010 | 17 patients | 3.2 years        | Displaced acetabular T-type fractures, 3 cases with central hip dislocation | Plate and screws. | Surgical hip dislocation: 10 patients. Stoppa approach: 2 patients Combined approach: 5 patients | Simple X-ray evaluation according to Matta’s criteria | Anatomic reduction was achieved in ten of the twelve patients (83%) without primary total hip arthroplasty. | One delayed trochanteric union, one heterotopic ossification and one loss of reduction. There were no cases of avascular necrosis. In two patients, a total hip arthroplasty was performed due to the development of secondary hip osteoarthritis. |
| Porter et al        | 2008 | 323 patients, 20 of them with T-Type acetabular fractures | 4-8 years | 20 T-type displaced acetabular fractures | Not specified | Not specified | Evaluation of the visceral organ injuries. | -Vascular 10% -Upper Extremity fracture 15% -Spleen 15% -Spine fracture 30% -Retroperitoneal Hematoma 35% -Lung 30% -Liver 5% -Low extremity fracture 40% -Kidney 5% -Brain 5% -Bowel 5% -Bladder 5% | Evaluation of the visceral organ injuries. |
| Hirvensalo et al. [16] | 2007 | 14 patients of a total of 164 patients with acetabular fractures | 3.9 years | 14 T-type acetabular fractures | Open reduction and internal fixation with plates and screws | Standard Anterior approach (most of the cases) / and posterior approach combined. | Harris Hip Scale and CT evaluation. | Not specified for T-Type fractures; good reduction in 84% of all patients, with a Harris Hip Score “Good” in 75%. | Not specified |
| Stökle et al.       | 2000 | 50 patients, 2 of them with T-Type acetabular fractures | 2 years | 2 T-type displaced acetabular fractures | Open reduction and internal fixation; with cortical screws of 5.5 mm. | Not specified | Simple X-ray and clinical evaluation and CT scan evaluation | Anatomic reduction (< 1mm) for the T-Shaped fractures. | Not specified |
- Visualization of the intraarticular damage is not possible.
- A simultaneous implantation of a total hip replacement is not possible through the same approach.

The case of an anterior hip subluxation following fixation of a T-shaped acetabular fracture through an extended iliofemoral approach. The substantial muscle exposure of the lateral aspect of the acetabulum and the circumferential capsulotomy related to the use of the iliofemoral approach were retained as factors promoting this complication. In case early postoperative mobilization is impossible, temporarily maintaining the limb in abduction and flexion can be recommended after an extended iliofemoral approach with circumferential Capsulotomy [18-21].

### Conclusion

Our literature review reveals that one of the main goals in the surgery of the fractures of acetabulum must be the anatomical reconstruction of the articular surface [22,23]. Not all complex fracture types have the same outcome, T-shaped fractures having the worst clinical results. Male gender, the use of an extensile approach, trochanteric osteotomy, presence of extensive cartilage injury, need of a complementary second approach, T-shaped fracture, or concomitant abdominal, chest, or head injury are associated with the formation of heterotopic ossification [12].
Surgical indications for acetabular fractures are: joint incongruency (>2 mm displacement), intrarticular fragments, hip joint subluxation or instability, posterior wall fracture with hip instability, roof arc measurement less than 45° on any simple Rx or progressive neurologic damage [24].

Nowadays, surgical indication with ORIF is the more frequently used. Non-surgical treatment is not preferred due to the longtime of weight bearing, inability to restore joint congruity surface and higher incidence of early hip osteoarthritis. In elderly patient, sometimes ORIF with percutaneous osteosynthesis is the main indication due to patients comorbidities although reduction of the fracture is not a perfect result [25,26].

ORIF allows surgeons to obtain anatomical reduction of the fracture, stable internal fixation and permit early mobilization of the joint. ORIF is more difficult as more complex is the fractures to reduce and this is the main reason of poor results in outcomes for beginners surgeons [26].

Trauma centres should designate a group of surgeons who will consistently treat these fractures in order to obtain more experience and better results. Acetabular surgery is demanding, and a high rate of complications can be expected.

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