Treatment of Acetabular Peri-Prosthetic Fractures

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Acetabular peri-prosthetic fractures are rare but their incidence is rising due to the increased prevalence of total hip arthroplasty, the increasing life expectancy and the growing functional demand of an ageing population, the incidence of primary total hip arthroplasty is increasing. They are either intra-operative or post-operative and have various aetiologies. Several factors such as implant stability, bone loss, remaining bone stock, fracture pattern, timing, age and co-morbidities of the patients must be considered for adequate treatment. To date, the literature on this subject has been sparse and no universally recognized treatment algorithm exists. Their rarity makes them a little-known entity and their surgical management represents a challenge for most orthopaedic surgeons.

Keywords: Treatment ; Acetabular Peri-Prosthetic Fractures ; acetabulum ; fracture

1. Intra-Operative Fractures

Intra-operative fractures might be difficult to detect. They should be suspected when the acetabular component does not achieve the expected press-fit fixation, or when the acetabular component protrudes more medially upon impaction. The treatment depends on the displacement of the fracture and the stability of the acetabular component.

Undisplaced intra-operative fractures with stable acetabular component (Pascarella type 1a and Paprosky and Della Valle IA) can be treated conservatively by toe-touch weight or non-weight bearing for 6–10 weeks [1][2][3][4]. If recognized during the surgery, the use of supplemental screws is recommended [4]. In those cases, a multi-hole cup is used as a plate and the component is stabilized by several posterosuperior (ilium) and posteroinferior (ischium) bicortical screws [1][3]. Some researchers suggest using autografts from the iliac crest to speed up the healing process [1]. For some researchers, non-recognized intraoperative fractures of the acetabulum (Paprosky and Della Valle type IC) have the same outcome that noncomplicated THA without further treatment [5].

Displaced and/or unstable Intraoperative recognized cups (Pascarella type 1b, Paprosky and Della Valle type IB) confront the surgeon with a tough decision. First, the component should be removed, the fracture line should be highlighted, and intra-operative radiographs should be obtained. Second, the integrity of both anterior and posterior columns should be assessed. If there is an important motion at the fracture site, the use of a cup as a plate is not effective and fixation of the fracture with standard reconstruction plates should be done prior to acetabular component insertion. One of the difficulties in the management of intra-operative fractures is to evaluate if fracture fixation can be performed adequately through the same approach. In most cases, the posterior wall is involved and might require fixation. If THA is performed using a direct anterior approach, an additional surgical approach might be needed to carry out the surgery.

2. Post-Operative Fractures

Post-operative fractures (Pascarella type 2, Paprosky and Della Valle type III) are divided into groups based on the stability of the cup. They are either acute, after a traumatic event, or chronic, due to osteolytic bone loss.

Non-displaced stable fractures (Pascarella type 2a, Paprosky and Della Valle type IIIA) can be treated non-operatively with 6–8 weeks of non-weight bearing [3]. Despite the paucity of articles treating this subject, conservative treatment carries a poor prognosis. In an article published in 1996, Peterson and Lewallen [6] reported that six out of eight patients treated non-operatively required surgery at 20 weeks, two for non-union and four for loosening despite fracture healing.

In displaced fracture with unstable cups (Pascarella type 2b, Paprosky and Della Valle type IIIB), surgery is needed [7]. The type of fracture according to the classification of Letournel [8] dictates the strategy. It is recommended to fix the fracture with standard reconstruction plates followed by a revision shell with multiple screws. Bone grafting might be necessary to fill the gaps at the fracture site[3][9][10]. Several methods can be used to fix the fracture depending on the surgeon's preference, including posterior column plating, anterior and posterior column plating, anterograde or retrograde anterior or posterior column screw fixation. Alternatively, in cases where primary fixation of the revision shell cannot be achieved, or if plating provides insufficient stability, Kerboull reinforcement rings, cup-cage constructs or antiprotusio cages can be used with cemented dual-mobility cups, as described later.

In chronic and osteolytic contexts (Pascarella type 2c), prosthetic revision with bone loss restoration is advised [3]. For this situation, researchers recommend the use of cup-cage constructs or antiprotrusio cages. Bone stock loss needs to be considered in these fractures and should be treated with allograft impaction grafting in contained defects, or with either bulk allografts or metallic augments when the acetabular rim is involved. In major osteolytic defects, and when all other options cannot be envisaged, stemmed acetabular cups anchoring into the iliac isthmus have been taken into consideration as a salvage solution. However, this type of implant which is used mainly in tumour resection surgery should be considered carefully, as high complication rates have been reported at five years, 31% of which require re-intervention [11][12].

3. Pelvic Discontinuity (PD)

Pelvic discontinuity (Paprosky and Della Valle type V) is a "distinct form of bone loss, occurring in association with THA, in which the superior aspect of the pelvis is separated from the inferior aspect because of bone loss or a fracture through the acetabulum" [13]. The preoperative diagnosis of this rare entity, found in 0.9–2.1% of acetabular revisions is, in the majority of the cases, not obvious [13][14][15].

PD can be distinguished into two entities, acute and chronic, each with a different potential for healing and biological bone ingrowth, thus requiring a different therapeutic approach. Furthermore, the percentage of bone loss needs to be incorporated into the treatment algorithm for PD. According to the Letournel classification, acute PD can be observed in both column, transverse, T-type, anterior column + posterior hemitransverse, and transverse + posterior wall patterns. Acute PD is either traumatic, typically occurring after a fall, or iatrogenic, following overreaming, implant impaction and removal [16]. The management of acute PD follows the same principles as those applied for postoperative fractures, and should be guided by the pattern of the fracture. In transverse fractures, ORIF of the posterior column and the use of a hemispherical acetabular shell can be successfully used to achieve good stability [14]. In the acute setting, the posterior plate provides extra-acetabular compression. Rogers and al. [14] reported 100% survivorship (no revision surgery, no reported infections and/or dislocations) on nine patients with acute PD with a mean follow-up of 34 months with this technique. Although not specifying if used in chronic or acute PD, Martin et al. [17] reported 80% revision-free survivorship of the posterior column plating technique with 22% complications, mostly infection and dislocation. In fractures of the anterior column, or in very unstable fractures such as in both columns and T-type acetabular fractures, an additional fixation with a pelvic reconstruction plate can be necessary to achieve rigid fixation of the fracture [18].

Chronic PD is progressive and occurs because of periprosthetic septic/aseptic osteolysis or age-related osteopenia [16]. Despite numerous publications and multiple treatment options, no universally recognized treatment algorithm exists. Their management differs significantly from that of acute peri-prosthetic fractures as successful reconstruction will depend on the amount of the remaining bone stock, the ability to achieve a stable cup fixation, and the healing potential of the discontinuity.

In chronic PD, the pelvis is very stiff, and specific reconstruction techniques might be required to achieve implant stability. Chronic PD with moderate bone loss (Paprosky and Della Valle type VA) and good bone quality can be treated with a posterior compression plate, bone grafting, and a revision shell acting as a plate. Alternatively, a Kerboull reinforcement device and bulk allograft can be used together with a cemented cup. With re-revision surgery as an endpoint, an excellent outcome with a 15-year survival rate of 85% has been reported [19].

In the treatment of PD with severe bone stock loss (Paprosky and Della Valle type VB and VC), the use of acetabular cages alone comes with unfavourable results and high failure rates up to 76% [20][21][22], due to mechanical loosening and fatigue fracture of the implant [20]. Therefore, the use of acetabular cages is not recommended in these situations [23]. Alternatively, three other techniques and devices could be considered:

- The "Cup-cage construct" technique, currently the most popular treatment of chronic PD [22], was first described by Hanssen and Lewallen in 2005 [24]. It consists of an ilio-ischial cage, placed over an uncemented highly porous metal cup. In a majority of the cases, "jumbo cups", defined by von Roth et al. [25] as an acetabular component with an outside diameter ≥66 mm in men and ≥62 mm in women, are used and thus help restore the centre of rotation (COR) of the hip in an anatomic position [26][27]. Remaining bone defects can be filled with augments or allograft. The cage offers initial stability and allows the osteointegration of the acetabular component. A polyethylene liner is then cemented in the cage in the correct position. Advantages of this technique are its favourable outcomes and high survival rates, ranging from 75–100% [17][22][28][29][30][31][32].

- Acetabular distraction was first described by Sporer et al. in 2012 [33]. The acetabulum is reamed until the antero-superior and postero-inferior margins are engaged. Remaining bone defects are filed with porous tantalum augments. An acetabular component of the same material, 6–8 mm larger than the last reamer is then impacted. The distraction creates a press fit and a pelvic recoil as a result of ligamentotaxis [34]. The latter in conjunction with multiple screws inserted in the remaining ilium and ischium provides initial stability. The polyethylene liner or a dual mobility cup is then cemented into the shell [33]. Although relatively new, acetabular distraction is a promising treatment for chronic PD.

- Custom-made triflange implants are another option to address chronic PD with severe bone loss. Based on a preoperative CT scan, an individually produced titanium, porous and/or hydroxyapatatite-coated triflange cup is made. Through the fixation of the three flanges, initial stability with the hip COR in anatomic position can be achieved. Excellent results and >80% survivorship of the implants are reported [22][35][36][37]. The disadvantages of this implant are high costs, long manufacture time (6 weeks) and the high rates of dislocation, up to 21% [22][35][36].

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