TECHNICAL NOTE

Total hip revision using a cup design with a peg to treat severe pelvic bone defects

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Loosening;
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Revision

Summary  When dealing with severe bone loss during acetabular revision of a total hip arthroplasty, it can be difficult to find a reliable anatomical structure to ensure high-quality primary fixation of the cup. Since 2003, we have been using an implant with a long peg that is anchored into the iliac isthmus. This structure is usually intact, even in the most severe situations of bone loss. The use of this specially designed component provides satisfactory mechanical reconstruction in cases that can be quite challenging (Paprosky and SOFCOT stage 3). The length and postoperative care for the procedure remain the same and early weight bearing is possible. The specific principles applying to this procedure, along with the anatomical features of the iliac isthmus, the implantation technique and our initial results are described in detail.
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Introduction

During total hip revision, the fixation of a new acetabular component [1] can be a challenge when potential fixation sites are no longer intact. A number of implants are available that can be screwed or impacted into the remaining surrounding structures, either directly [2–4] or through the use of a reinforcement ring [5–7]. Bone defects in the area can be rebuilt with autologous grafts or allografts. However, when the bone loss is severe and the acetabular component has migrated, massive structural grafts [8–13] or morselized, impacted grafts [2,11,14–16] must be used, which increases the risk of early failure [4,17,18]. We wanted to find a reliable anatomical structure that would still be intact in the most severe cases of bone loss. The iliac isthmus meets these requirements. We developed a revision cup with a peg that is anchored into the intramedullary space of this isthmus. The goal of this technical note is to provide the anatomical basis for this cup, describe the surgical technique and report on our initial results with this device.

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Implant with peg for challenging acetabular revision cases

Figure 1  CT scan image of the iliac isthmus (iliopubic beam).

Anatomical basis

The iliac isthmus (or ilio púbic beam) is the lateral part of the upper segment of the ilium between the roof of the acetabulum and the sacroiliac joint. Testut and Latarjet [19] describe this structure as a long bone with a short diaphysis and a medullary canal. It has also been described by Michele [20] and Judet and Letournel [21].

Tricóire et al. [22,23] also evaluated this isthmus on cadavers, dry bones and pelvic CT scans (Fig. 1). It is a concave structure, oriented upwards, backwards (30°) and inwards (10°) along the axis of the sacroiliac joint that transmits the forces between the lower limb and spinal column. The isthmus has a curvilinear diabolo shape that flares out at both ends onto two articular surfaces, the upper pole of the acetabulum and the sacroiliac joint. The average length is 69 mm, with a range of 55 to 80 mm. The medullary canal is 19 mm in diameter at its narrowest point; the cortex is between 3.5 and 4.0 mm thick. This iliac isthmus appears to be a reliable, extremely solid structure. It has been found to be intact in revision arthroplasty cases, even in the most severe cases of osteolysis [24–26].

Description of the Integra cup with peg

The Integra cup with peg (Lépine, Genay, France) is a cementless, dual mobility implant [27]. The cup has three parts (Fig. 2):

- the shell of the cup, which is symmetric and has a long peg. This titanium shell is coated with porous titanium and 80 μm hydroxyapatite. It is available in four sizes; there are four holes that can be used for additional stabilization screws. The 50 mm long peg has an epicycloidal cross-section that is 11 mm in diameter or 8 mm when not including the ridges. The peg has a 55° angle relative to the opening of the cup;
- a stainless steel insert that is impacted into the bottom of the cup and articulates with the polyethylene liner;
- a constrained polyethylene liner that allows for dual mobility. The two smaller sizes accept 22 mm femoral heads and the two larger sizes accept 28 mm heads.

Figure 2  The Integra cup with peg has three components: the acetabular shell, mobile metal insert and dual mobility polyethylene liner.

1) Line that bisects upper quadrant
2) Reaming guide aligned along isthmus axis

Figure 3  The entry point into the isthmus is located in the middle of a line that bisects the upper (iliac) quadrant.

Figure 4  Alignment instrumentation: short reaming guide and manual cannulated reamer.
Surgical implantation technique

After preoperative planning with X-rays and CT scan, the seven-step procedure is performed with the patient in lateral decubitus:

- long lateral incision. An extended trochanteric osteotomy is preferred if the femoral component must be changed. A conventional trochanteric osteotomy or postero lateral approach can also be used;
- identification of sciatic nerve and exposure of greater sciatic notch. With sufficient exposure, the surgeon can slip a finger under the curved portion of the notch; its vertical anterior edge is the posterior face of the isthmus;
- removal of current implants and reaming;
- medullary canal of the isthmus is hollowed out to prepare a path for the peg. The peg’s entry point is located in the middle of a line that bisects the upper quadrant of the acetabulum (Fig. 3). The squared end of the first reamer must not sink more than 5 mm into the medullary canal. The guide is aligned along the axis of the iliopubic beam, by hooking a finger under the isthmus area. The proper alignment is upward, 10° inward and 30° posterior in the direction of the posterior superior iliac spine. Drilling is performed manually with a blunt instrument. Powered instruments are strictly prohibited. A blunt drilling guide is used during this step for safety (Fig. 4). The guide is advanced into the iliopubic beam until contact is made with the sacroiliac joint. False passages can occur above the acetabulum, into the iliac or gluteal muscle, but they are harmless because a blunt instrument is being used. The entry point and trajectory can be corrected with the blunt drilling guide. This step can be more empirical when faced with highly sclerotic bone in cases with upward cup migration. A hand drill of the same length as the peg is placed on the guide wire;
- the trial cup is inserted by placing the peg into the path that was prepared in the isthmus. The bottom of the cup will sit flush in the remaining parts of the acetabulum. The cup’s inclination and anteverision are set by rotating the cup on the peg axis;
- the final implant and stainless steel insert are impacted. We rarely use any additional locking screw.
- corticocancellous autografts or allografts are used to fill any bone defects (Fig. 5).

Figure 5  a: Preoperative X-rays showing the cranial migration of the cup and SOFCOT grade 3 bone loss [1]; b: one year postoperative X-ray showing the stable and satisfactory positioning of the cup; an allograft was used the fill the bone defect; c: CT scan to assess the positioning of the peg in the isthmus at one year post-surgery.
Table 1 Results from our preliminary series (48 cases).

<table>
<thead>
<tr>
<th></th>
<th>Average (Std. Dev.)</th>
<th>Median (min-max)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>74.1 (9.3)</td>
<td>76.0 (53–96)</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>24 (50)</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>24 (50)</td>
<td></td>
</tr>
<tr>
<td><strong>Grading of acetabular bone loss according to SOFCOT classification [1]</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 1</td>
<td>6 (12.6)</td>
<td></td>
</tr>
<tr>
<td>Stage 2</td>
<td>21 (43.7)</td>
<td></td>
</tr>
<tr>
<td>Stage 3</td>
<td>21 (43.7)</td>
<td></td>
</tr>
<tr>
<td>Stage 4</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Results</strong></td>
<td></td>
<td></td>
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<tr>
<td>Follow-up (months)</td>
<td>28.0 (21.3)</td>
<td>29.6 (1–75.3)</td>
</tr>
<tr>
<td>Preoperative PMA score [28]</td>
<td>6.4 (3.2)</td>
<td>8 (0–13)</td>
</tr>
<tr>
<td>PMA score at follow-up</td>
<td>15.7 (2.4)</td>
<td>16 (7–18)</td>
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<tr>
<td><strong>Probability of survival</strong></td>
<td></td>
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<tr>
<td>Results at 28 months</td>
<td>94.1%</td>
<td>[78.3–98.5]</td>
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<tr>
<td>Revisions</td>
<td>n</td>
<td></td>
</tr>
<tr>
<td>Technical problems</td>
<td>2</td>
<td>Cup was too small; revision with Kerboull reinforcement device five months later; poor result</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wrong trajectory of the peg with protrusion; revision one year later with Burch-Schneider cage; very good result at five years</td>
</tr>
<tr>
<td>Infections</td>
<td>1</td>
<td>Early revision at day 10, without changing implant; currently healed (2 year follow-up).</td>
</tr>
<tr>
<td>Neurovascular</td>
<td>0</td>
<td>No postoperative deficits</td>
</tr>
</tbody>
</table>

* Calculated based on the Kaplan-Meier method; the need to change of all or part of the implant for any reason was considered as the end-point for the analysis.

Results

Table 1 provides the results for our preliminary series of 48 cases with a minimum of 28 months follow-up. Other than the two mechanical failures in our first cases, the results were highly satisfactory when the severity of the preoperative bone defects is taken into consideration: 44% of patients were rated at least stage 3 in the SOFCOT classification [1].

Discussion

Solid primary fixation with this implant takes precedence over the position of the center of the hip. The peg provides most of the primary stability and improves bone integration by increasing the bone contact area [29]. Our preference is to have a slightly elevated cup that has good primary fixation in living bone, instead of centering the cup by using bone grafts, which can result in uncertain fixation [4,17,18]. If the upward placement of the cup is less than 5 mm, the results will not be worse [30,31]. However an elevated hip center would not be acceptable in a young patient because the hip biomechanics and life span of the arthroplasty would be compromised [4,32–34]. These cases and transverse fractures of the acetabulum are the limitations of this technique. The potential for postoperative instability is greater in revision cases than in primary arthroplasty [35,36]. Besides it can be difficult to perfectly orient the cup because the peg rotation, cup inclination and cup anteversion are all interrelated. We chose a dual mobility option to eliminate the possibility of instability in most cases [37–40]. Corticocancellous bone grafts were used to fill bone defects; since these are not structural grafts, they do not add to implant stability.

The iliac isthmus has been used for acetabular fixation by other surgeons. Ring [41,42], Mac Minn et al. [25], Badhe and Howards [43], Perka et al. [44] and Santori et al. [45] suggested using implants with pegs or screws that are fixed into the isthmus during revision surgery when faced with severe bone loss or in cases of dysplasia. Similarly, the saddle prosthesis [26] in anchored under the inferior edge of the isthmus. In some published series, the isthmus is described as a consistent, solid and reliable structure, but instability is common because of challenges related to cup orientation [44,45]. Acetabular reconstruction with the iliac isthmus after tumour resection is described in a few, short-term studies [46–48]. These published series confirm our approach but we wanted to improve hip stability by using dual mobility cups. Likewise, we modified the surgical technique since we believe that reaming the isthmus with an alignment device is extremely dangerous.
Conclusion

The Integra cup with peg is a cementless, dual mobility implant. Primary fixation in healthy bone is performed by anchoring the peg in the ilipubic beam. It is mainly indicated in SOFCOT stage 3 revisions. Our initial results are satisfactory, but must still withstand the test of time.

Disclosure of interest

Dr Pierre Desbonnet, Dr Joël Trouillas and Dr Philippe Escare are co-designers of the Integra cup and receive royalties from Groupe Lépine. Dr Jean-Louis Tricoire and Dr Henri Connes have no conflicts of interest to declare relative to this publication.

References

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