Role of Distal Locking Screws in Stability of Modular Cementless Revision Total Hip Replacement

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Abstract: Removal of a prosthesis stem in hip revision arthroplasties can cause intraoperative femoral defects or fractures that need to be bridged by long revision stems. Twenty four revision total hip arthroplasties were performed, 12 of 24 hips using a modular stem with distal locking screws, whereas the remaining 12 hips using the same modular stem without distal locking screws. After follow-up of 1 year the mean postoperative Harris hip score among the patients were 76.9 points. Complications included intraoperative diaphyseal fractures in 6 cases, infection in 1 case, and dislocations in 3 cases. One year postoperative Harris hip scores, and femoral component stability did not differ between the 2 groups whether treated with or without screws. Application of distal screws increased operative time and led to fracture of femur in 2 patient. Stem subsidence (3 mm) occurred in one case in the group treated without distal locking screw. Interlocking screws can be indicated only if no secure circular surface fixation nor three surface fixations can be achieved during modular stem application.

Key words: total hip arthroplasty, revision, cementless, modular stem.

INTRODUCTION

As primary total hip replacements become more common in younger physically active patients, the number of revision arthroplasties will also increase. Removal of a femoral stem in hip revision arthroplasties, severe femoral osteolysis or thick femoral cement mantles can cause intraoperative femoral defects or fractures that need to be bridged by long revision stems. These problems led to the evolution of modular cementless femoral stems. Modularity in cementless femoral revision permits independent fitting of the diaphysis and metaphysis; correct adjustment of length, offset, and version to facilitate the reconstruction of the proximal femur and to offer ultimate clinical performance[1-2,3]. Stability of cementless femoral revisions depends on achieving initial axial and torsional stability by maximizing canal fill at time of implantation. Bone ingrowth correlates with the ability to fill the femoral canal[6,5]. Interlocking screws have important role in primary mechanical stability as they help to guarantee stable fixation preventing the rotation& subsidence[6]. Interlocking screws are indicated only if no secure press fit fixation can be achieved[7]. The aim of this work is to evaluate the role of distal locking screws in stability of modular cementless long stem in revision total hip replacement.

MATERIALS AND METHODS

In this prospective study, that was conducted between May 2006 and June 2008, 24 revision hip arthroplasties were done using modular cementless long stem implant. The patients were randomly divided into 2 groups (12 cases of patients were done with modular cementless long stem with distal locking screws & the other 12 cases were done with the same modular stem without distal locking screws). The implant has to be adapted exactly to the diameter of the femoral medullary canal and fixed distal 6 cm at least to the defect zone. Two modular systems were used, REVITAN® SYSTEM of Zimmer[7]with rough-blasted surface in which the distal locking screws are available from stem size 18. All the cases in which we used Revitan system with size less than 18 were excluded from study. And the 2nd stem was REEF MODULAR STEM of Deupy Orthopaedics Inc., Warsaw, Ind.[8] with surface fully coated by hydroxyapatite, with distal locking screws available in all sizes (Fig.1). There were 18 males and 6 females. The average age of the
patients at the time of the operation was 55 years (range 49-77). The average weight of the patients was 79 kg (range 48-92). The range of stem diameters used in this study was 16-24 mm (Table 1). The causes of revision were: aseptic loosening of cup and stem for 18 cases, peri-prosthetic femoral fractures for 1 case, neglected dislocated total hip replacement for 2 cases, and septic loosening after 2 stages revision for 2 cases.

The patients were evaluated clinically and radiologically. The Harris Hip Score\textsuperscript{[10]} was measured preoperatively. Pre-operative templating was essential in all cases in order to determine the size of the stem. The general goals were to restore as nearly as possible the anatomic or pre morbid center of rotation of hip and femoral offset, while equalizing limb length.

The lateral (modified Hardening) approach was used for 14 patients and the posterior approach was used for 10 patients.

Trans-Femoral osteotomy (Extended proximal femoral osteotomy) was done for 7 cases in order to avoid intraoperative fractures and femoral perforation as it allows direct access to the distal canal of the femur for removal of distal cement, efficient preparation of the fixation area for the new prosthesis, also it gives possibility to adjust abductor laxity by moving the trochanter. All osteotomies were re-duced and fixed by circulage wire& all united within 3-6m. (fig. 2). Trochanteric osteotomy was done for 3 cases for improved exposure of the superior and lateral aspects of the acetabulum. All trochanteric osteotomies were attached by circulage wire& all united within 3-6m. Without osteotomy was required for 14 cases.

Antithrombosis prophylaxis with subcutaneous low molecular weight heparin and antithrombosis stockings were used for all patients. The LMWH was started 12hours before the operation and continued for 3 weeks post operative. Antibiotics (Amoxacillin with sulbactum) were given for one week for all patient, except the cases with history of infection, the antibiotics were given for 4 weeks. Suction drains was used for all patient and were removed after 36 - 48h. The patients were allowed partial weight-bearing with two crutches for 6- 12 weeks after the operation for all patient in the two group. The average hospital stay was 3 weeks.

The average follow-up time for all 24 patients was 1 year (range 6m- 2y). The patients were evaluated clinically and radiologically. The Harris Hip Score\textsuperscript{[10]} was measured postoperative at 3m,6m,&1y. The patients' satisfaction with the outcome of the operation, functional capability, and the presence of thigh pain were noted.

Femoral bone defects was evaluated according to the American Academy of orthopaedic Surgeons Classification (AAOS). The femoral deficiencies were as follows\textsuperscript{[9]}:

- Segmental defect, level II in two cases.
- Cavitary defect, grade I, level II in one case.
- Cavitary defect, grade II, level II in twelve cases.
- Combined defect, cavitary grade II, level II and segmental level II in five cases.
- Malalignment in one case.
- Discontinuity in three cases.

\textbf{Table 1: Diameter of the revision stemi}

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<th>Diameter of stem</th>
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<tr>
<td>16</td>
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<tr>
<td>18</td>
<td>10</td>
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<tr>
<td>20</td>
<td>5</td>
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<td>22</td>
<td>2</td>
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<td>24</td>
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The lateral (modified Hardening) approach was used for 14 patients and the posterior approach was used for 10 patients.
Radiological evaluations of the Cementless Femoral Components were done using the criteria proposed by Engh\textsuperscript{[11]}. Assessment was as follows: day one postoperative x-ray, after 6 weeks, after 3 months, after 6 months and after 1 year then every year.

Fig. 2: Transfemoral osteotomy

The following items were looked for in the x-rays:

- Appearance of lines or luencies.
- Remodeling and refill of the proximal femur.
- Presence of spot welds.
- Calcar modeling (atrophy, hypertrophy or undetermined changes).
- Presence of pedestal.
- Subsidence & change of position. Subsidence was checked by measuring the distance in millimeter between fixed points in the stem (modular junction) and a fixed point in the proximal femur (upper border of greater trochanter or/and lower border of lesser trochanter). This was measured on each follow up and compared to previous X ray to detect subsidence. Rotation was checked on consecutive follow up X ray while the limb is in exact position to detect any rotation.

RESULTS AND DISCUSSION

Results: The Harris Hip Score improved from preoperative 41.2 (3-70) to postoperative 76.9 (67-97). The intraoperative and postoperative complications are defined in Table 2. The main intraoperative complication was femoral fracture in 6 patients. In two of these patients' fractures occurred during application of the distal locking screws (Fig.3). Three of these fractures were fixed by plate & screws, and the other three fractures were fixed by circulage wires. All the fractures united within 3-6 months. Single dislocation occurred in three cases and was treated by closed reduction. Recurrent dislocation occurred in one case due to extreme position of the limp and was treated by closed reduction, abduction hip brace for 6 weeks. One year follow up showed stability of the joint.

Table 2: Complication

<table>
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<th>Complication</th>
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<tr>
<td>Intraoperative Femoral fractures</td>
<td>6</td>
</tr>
<tr>
<td>Single dislocation</td>
<td>3</td>
</tr>
<tr>
<td>Recurrent dislocation</td>
<td>1</td>
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<tr>
<td>Subsidence of the stem (more than 2mm)</td>
<td>1</td>
</tr>
<tr>
<td>Infection</td>
<td>1</td>
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<tr>
<td>Limb length discrepancy (lengthening more than 2 cm)</td>
<td>2</td>
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Post operative infection occurred in one patient, for whom the cause of revision was septic loosening. This patient had pain in walking for long distance, but still the patient refuses to have another revision. In all cases healing of bony defects of the diaphysis was detected. There was no progressive osteolyses on the last radiographs in 22 patients. Stem subsidence of more than 2 mm was seen in one patient in the group without distal locking screws but follow up radiographs revealed secondary stabilization of the stem. In this case a decision to use an overly small diameter stem was taken in order to avoid femoral fracture due to the poor bone quality.

Fig. 3: Male patient 64y, (A: pre-operative, B&C: femoral fractures occurred during applying the distal locking screws and fixed by plate & screws, D: 6m post-operative union of fracture was occured).

The radiographic examination after an average of 1 year revealed a stable stem anchoring with a good bone-prosthesis contact and spontaneous healing of the defects in all cases(table.3). Not only no difference was noted in the stability of the stem nor the satisfaction of the patients on whom the stem was applied with or
without screws (Figure 4&5), but also application of distal screws increased operative time & led to fracture of femur in 2 patient.

Table 3: Radiological result

<table>
<thead>
<tr>
<th>Lines or luencies</th>
<th>1 case</th>
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<tr>
<td>Spot welds</td>
<td>10 cases</td>
</tr>
<tr>
<td>Calcar atrophy</td>
<td>3 cases</td>
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<tr>
<td>Pedestal</td>
<td>1 case</td>
</tr>
<tr>
<td>Subsidence</td>
<td>1 case</td>
</tr>
<tr>
<td>Refilled of proximal femur</td>
<td>11 cases</td>
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Fig. 4: Demonstrates the case of a 66 year-old male patient undergoing revision arthroplasty of the hip using cementless long stem with distal locking screw. (A. preoperation- B.1 day after operation- C.1y after operation).

Fig. 5: Demonstrates the case of a 50 year-old male patient undergoing revision arthroplasty of the hip using cementless long stem without distal locking screw. (a.preoperation- b - c.1y after operation).

Discussion: Femoral component revision continues to be a challenging problem for orthopaedic surgeons where removal of a prosthesis stem in hip revision, severe femoral osteolysis or thick femoral cement mantles can cause intraoperative femoral defects or fractures leading to difficulty in achieving mechanical stability that needs to be bridged by long revision stems. The implant has to be adapted exactly to the diameter of the femoral medullary canal and fixed distal at least 6 cm to the defect zone. Aseptic loosening is the most common mechanism of failure of total hip arthroplasty necessitating revision.

Periprosthetic fracture, implant failure, osteolysis, sepsis and recurrent dislocations represent other indications for hip revisions. Results of cemented revisions of femoral components are unpredictable, and the intermediate term results are discouraging. The poor results with cemented revisions have led investigators to explore cementless options. The cementless femoral component progress from press fit components, to porous coated stems either partial or extensive, to custom-made femoral components, finally to modular femoral components. The modular stems have been classified as distally, midstem, or proximally modular, depending on the site of locking. The fully coated monoblock cementless femoral stem for total hip arthroplasty was developed to achieve a biological fixation of the stem by an integration of the femoral component into the bone to increase the longevity of the implant. The fixation of the femoral component to the diaphysis depends on the bone–implant-contact, the surgical preparation of the femoral canal, and the high degree of initial torsional and axial stability. Distal fixation by means of bone ingrowth or ongrowth is certainly possible, and the canal filling stems have a good track record. The disadvantages of distal fixation are the inevitable stress shielding that delay or prevents complete bone recovery, that it may produce thigh pain, and that it is difficult to revise. Modularity in cementless femoral revision permits independent fitting of the diaphysis and metaphysis; correct adjustment of length, offset, and version to facilitate the reconstruction of the proximal femur and to offer ultimate clinical performance. The principle of modular uncemented diaphyseal fixation seems capable of solving most of the technical problems as femoral bone loss, joint instability, periprosthetic fractures, function of the pelvirochanteric muscles, and leg length discrepancy.

Our study was a prospective one, involving 24 cases that underwent revision hip arthroplasty using cementless modular femoral stem. The Harris Hip Score improved from preoperative 41.2 (3-70) to postoperative 76.9 (67-97). We couldn’t find a big difference in the results (stability, subsidence & rotation) between the two groups. Subsidence occurred in one case in group without distal locking screws, one year follow up showed no progressive subsidence. This very low rate of subsidence may be attributed to:

- Insistence on reaming until tight distal fit is reached.
- Good closure of the osteotomy site.
- Controlled weight bearing.
Using distal locking screws consume extra time over already long time of operation (Fig. 6). Periprosthetic fractures of femur occurred in two cases during the application of the distal locking screws. Which were fixed by plate & screws in same sitting. When our results were compared with the few published studies on the same domain, we encountered the following data; Brend et al[17] presented 68 hip revisions (stem without distal locking screws) and followed them clinically and radiographically for 24 months. The osteotomy showed bony consolidation in all but one case. We noted subsidence in six cases and two of these stems became loose. The Harris hip score improved from 41.4 ± 14.5 points preoperatively to 85.9 ± 14.6 points 24 months postoperatively.

Melnis et al[19] reported a retrospective review of 70 stems (Fluted, Tapered, modular stem without distal locking screws) with a mean follow-up of 47 months. Three hips were rerevised. Subsidence occurred in (59/70) of hips, and the mean for the group was 9.9 mm (range, 0-52 mm). Dislocation in 7 of 70 hips, and fracture or cortical perforation in 17 of 70.

Stability of cementless femoral revisions depends on achieving initial axial and rotational stability by maximizing canal fill at time of implantation. Bone ingrowth correlates with the ability to fill the femoral canal. Increased initial axial and rotational prosthetic stability decrease micromotion and allow for long-term biologic fixation. Maximizing canal fill not only provides prosthetic stability, but also provides a circumferential biologic seal after bone ingrowth to prevent wear debris from migration distally and creating osteolysis[5]. Interlocking screws have important role in primary mechanical stability as they help to guarantee stable fixation preventing the rotation[6]. The design of this cementless femoral component is based on providing diaphyseal primary stabilization and metaphyseal secondary fixation by the growth of bone tissue onto the proximal part of the prosthesis. Primary axial stability is achieved using shaft design, and distal screw interlocking[12].

Interlocking screws can be indicated to achieve stability of modular stem in these cases:
- No secure circular surface fixation nor three surface fixations can be achieved during modular stem application.
- Periprosthetic fractures with long spiral fractures in or above the isthmus region.
- Osteoporotic femur.

However, we agree with that additional distal locking screws should be viewed as an additive safety measure in exceptional cases. It should not be routinely used, nor does it permits one to dispense with a secure three surface fixation or circular surface fixation, if this is technically possible.

**REFERENCES**