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The Incidence of Dislocation Utilizing a Neck Sparing Stem in Primary THA in Community Based Practices with the Posterior Approach

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Abstract

This study retrospectively reviews the clinical results of a novel proximal neck-sparing cementless prosthesis for primary Total Hip Arthroplasty (THA). This neck-sparing prosthesis preserves the entire circumference of the femoral neck. The porous coated surface is located only within the femoral neck region. This study group included 338 primary THA's from three institutions. All approaches and techniques were similar, using a postero-lateral approach in all cases. Average follow-up was 38 months (range 12-56 months). There were five stem revisions (1.5%) in this group. Two stems were revised for aseptic loosening, two were revised for recurrent dislocation, and one was revised for a chronic periprosthetic infection employing a two-stage protocol. We had 3 dislocations (0.88%) and all three had re-operations. The neck sparing prosthesis is alluring as it saves almost the entire femoral neck and requires minimal deep posterior soft tissue releases. Our dislocation rate in this series was low. Insertion of a neck sparing prosthesis requires fastidious preparation and gentle insertion, but we find this design to provide reliable clinical function at short-term follow-up.

Keywords: *THA, hip, arthroplasty, posterior approach, dislocation, neck sparing, and risk factors, primary*
Level of Evidence: *AAOS Therapeutic Level III*

Introduction

Total hip arthroplasty (THA) is one of the most effective orthopedic procedures, providing consistently high success rates across all population segments—as measured by pain relief, improved function, and patient satisfaction [1,2,3,4,5]. As a result of these good outcomes, THA indications have been expanded to include younger and more active patients [6,7]. However younger patients are more likely to need revision surgery, and complications are higher with revision THA procedures [7,8,9].

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With the increased likelihood that younger patients will require a revision surgery later in life, it is advantageous to maximize proximal femoral bone stock to provide as much bone as possible for revision stem implantation [10]. Preservation of the entire femoral neck using a neck sparing prosthesis is a newer surgical technique that started in Italy and has now been widely used in the last decade [11,12]. Neck sparing implants potentially have the advantage of less thigh pain and are helpful to the surgeon when using a small incision approach. In addition, there is a mechanical advantage in retaining the femoral neck which results in a reduction of torsional forces placed on the implant / bone interface [1,13] (Figure 1). One potential problem with retaining a majority of the femoral neck is there is a chance for boney impingement. This can lead to residual pain, dysfunction, and possible dislocation. In this study we review the early clinical results utilizing a cementless proximal coated neck sparing femoral stem prosthesis. We wanted to assess our dislocation rate and clinical results from multiple surgery centers, all utilizing a postero-lateral surgical approach.

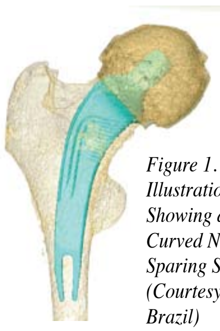

Figure 1. Illustration Showing a Short Curved Neck-Sparing Style Stem (Courtesy Declan Brazil)

Material and Methods

Between April 2010 and June 2014 we performed 338 short-curved neck-sparing stems (ARC™ Stem, Omni, E. Tauton, MA) (Figure 2). The three senior authors (surgeons) utilized the postero-lateral approach on all cases [14]. All three surgeons along with the two additional coauthors were all involved with the early development of both the stem and instrumentation. Preoperative training with cadaver workshops was a requirement prior to any clinical surgical evaluation of this device (Figure 3). Intra-operative x-rays or fluoroscopy were also required in the early stage of surgical implantation (Figure 4). Limited weight bearing was advocated for the first 4-6 weeks since the porous coating is limited to the proximal portion of the stem that engages with the femoral neck.

Figure 2. Illustration Showing ARC™ Neck-Sparing Stem (Omni, E. Tauton, MA)

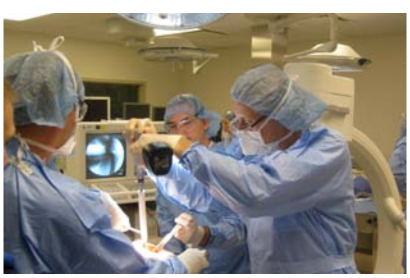

Figure 3. Cadaver Work Shop. (Courtesy JISRF Archives)

Figure 4. Intraoperative X-Ray Showing Trial Rasp with Trial head/Neck and Cup in Place. (Courtesy JISRF Archives)

The ARC stem design features a short curved titanium alloy stem with a novel conical flair for enhanced proximal compressive loading of the medial calcar (Figure 5). The proximal third of the stem has commercially pure titanium plasma spray coating with a surface layer of hydroxyapatite (HA) coating (25μm) to promote an early biologic bone healing to the implant. The modular femoral neck is made of cobalt chromium alloy and allows for intra-operative adjustment of joint stability, leg length and offset [15] (Figure 6).

Figure 5. Illustration Showing the Proximal Conical flair of the Stem Designed to Provide Compressive Loading to the Medial Calcar of the Stem. (Courtesy JISRF Archives)

Figure 6. Picture of ARC™ Stem Showing Modular Necks in various positions (Valgus, Neutral & Versus) Co-Cr-Mo, Ceramic Head Taper 12/14, Titanium Alloy Stem with Proximal Porous Pure Titanium Plasma Spray Coating with a Surface Layer of HA Coating. (Courtesy JISRF Archives)

All acetabular components were a variety of cementless titanium alloy porous coated hemispherical designs and bearing surfaces. All head diameters were restricted to 32 mm or larger. In the smaller patient profile, if a 32 mm head size could not be reached, a dual mobility style implant was chosen. Early in this series two of our surgeons used a limited number of large metal on metal (MoM) bearings. The MoM bearing was discontinued due to rising concerns in the market with this type of bearing surface [16]. A total of 77 dual mobility acetabular components were used with 66 being the Active Articulation design (Biomet, Warsaw, IN) (Figures 7a, & b). The dual-mobility concept utilizes a 28mm femoral head that articulates and is locked into a large polyethylene head. The large polyethylene bearing serves as a large head bearing that articulates within the all-metal monolithic cup.

Figure 7a. Picture of a dual mobility acetabular component (Active Articulation, Biomet, Warsaw, IN) (Courtesy McPherson)

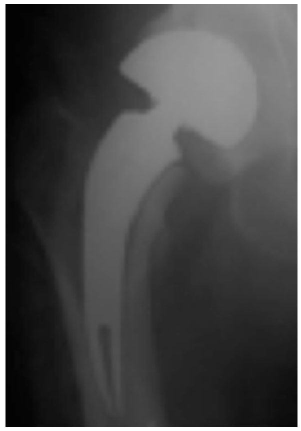

Figure 7b. Postoperative X-Ray Showing ARC Stem with a Dual Mobility Cup. Notice Tight Femoral Canal (Dorr I) Distal Slot Pinched In. (Courtesy Keppler)

Surgical Technique for Neck Sparing Prosthesis

The neck sparing femoral stem essentially retains the femoral neck in its entirety up to the upper ¼ neck region. Using the postero-lateral approach to the hip, the superior one-half of the short external rotators are released from the posterior greater trochanter down to the base of the femoral neck. The capsule is preserved with transverse incisions made at the acetabular rim and the base of the femoral neck. A longitudinal capsular incision is made in between. This creates anterior and posterior capsular flaps that can be repaired at closure. Once the hip is dislocated, the femoral neck is resected 5 to 10 mm below the subcapital junction with a fine-toothed saw (Figure 8). The neck cut is based upon preoperative and intra-operative templating to restore head center of rotation. The neck sparing stem design and instrumentation is based upon following the native medial curvature of the proximal femoral neck (Figures 9a, b, & c). Since the femoral neck cortical bone is distinctly thinner than the cortical femoral shaft, preparation of the proximal femur is more delicate. Rasping is gentile and broaching is performed with a small mallet with frequent light impactions. Trialing of implants is performed with modular neck trials to optimize hip length, hip offset, and hip stability. Once definitive hip implants have been placed a meticulous posterior closure is performed. The hip capsule is closed as a separate layer. In all cases the hip capsule was closed from the superior acetabulum down to the prosthetic femoral neck. In some cases, where possible, the entire hip capsule was closed. The proximal short external rotators are repaired to the posterior greater trochanter with sutures placed into bone. All soft tissues are anatomically closed as best possible.

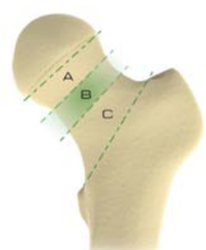

Figure 8. Illustration Showing Neck Resection Zones. Zone B being 5-10 mm as recommendation . (Omni Surgical Technique)

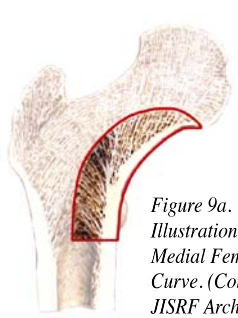

Figure 9a. Illustration Showing Medial Femoral Curve. (Courtesy JISRF Archives)

Figure 9b. Picture Showing Rasp Shaping Medial Femoral Curve to Stem Shape. (Courtesy JISRF Archives)

Figure 9c. Rasp and Femoral Stem Comparing Medial Curvature of the Stem. (Courtesy JISRF Archives)

Results

In our combined series there were 338 implanted short curved neck-sparing stems. Fifty-nine percent of patients were female and 41% were male. At an average follow-up of 38 months (range 12-56 months), Harris Hip Scores averaged 91.2 (range 78-100). There were three dislocations in this series (0.88%), all of which required revision surgery. In one case, the modular neck was exchanged to add 3.5mm in length and the acetabular polyethylene liner was also exchanged to add a 15º posterior hood. The stem was well fixed and retained. In the two other cases, the femoral stems were revised to conventional length stems, along with exchange of the modular acetabular polyethylene to add a posterior hood.

There were five stem failures in this study group. As noted above, two stems were revised for recurrent dislocation (0.6%). In both cases the femoral stems showed stable boney integration and were removed without difficulty. Two stems have been revised for aseptic loosening (0.6%).

They were both converted to conventional length primary hip stems. One stem was removed for chronic periprosthetic infection utilizing a two-stage protocol (0.3%). The stem was easily removed by making a circumferential femoral neck bone cut with a small sagittal saw at the lower 1/3 neck region. Bone loss was minimal (Figure 10). The overall revision stem rate in this series was 1.5%. There was also one acetabular cup revision for aseptic loosening in this series. In this case, the modular femoral neck was removed and exchanged in order to facilitate acetabular exposure (Figure 11).

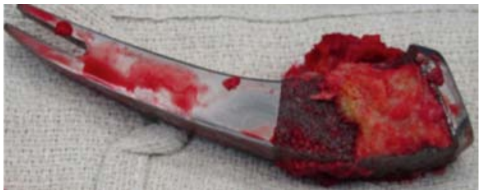

Figure 10. Retrieved ARC Stem with Good Bone Attachment to Proximal Porous Coating. (Courtesy JISRF Archives)

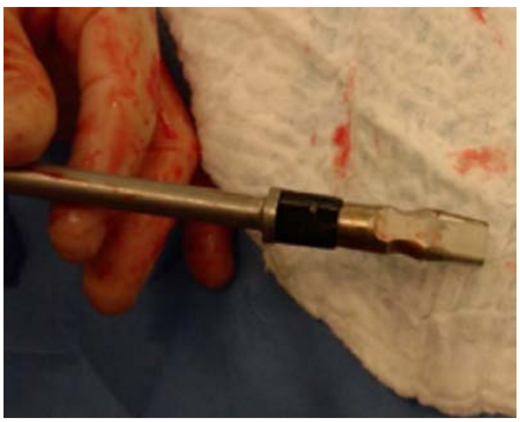

Figure 11. Picture of Explanted Modular Neck. No signs of Corrosion. (Courtesy JISRF Archives)

In this series we were able to examine the seven modular necks that were either revised or exchanged. Even though these cases were revised relatively early in the life cycle of these implants, we observed no signs of corrosion between the modular femoral neck and the femoral stem body.

Discussion

In the last decade there has been a push towards utilizing the anterior hip approach for THA [17]. Advocates of this approach have criticized the posterior approach for its higher rate of dislocation. Historically dislocation results in the posterior approach (with complete detachment of the external rotators) varied between (4.8% to 7%). Revision surgery for recurrent dislocation has a significant impact upon patient morbidity and psychological stress. Furthermore, it imparts a significant financial burden on the healthcare system [18,19]. About 45% of dislocations occur within 4 weeks of surgery [19]. Various risk factors such as surgical approach, cup position, combined cup and stem anteversion, and femoral head size can impact clinical outcomes. However, the data supporting this view does not include more recent changes in surgical technique and implant technology. Recent changes that have reduced dislocation rates include careful preoperative templating to recreate joint center of rotation, neck-sparing implants that require little in posterior soft tissue releases, and finally techniques that emphasize a complete posterior soft tissue repair.

Restoration of hip mechanics is vital to providing optimal hip function and stability. Careful preoperative templating allows the surgeon to determine appropriate reaming depth for the acetabulum. Furthermore, careful templating determines lateral hip offset and vertical length as referenced from hip center. Preoperative templating facilitates intra-operative assessment and bone preparation for placement of THA implants. Even through preoperative templating is important, intra-operative templating with femoral neck measuring jigs must be utilized to corroborate preoperative measurements. Hip templating may provide false values especially when the arthritic hip is contracted into external rotation. In this position the femoral neck can appear more valgus and vertical. Offset can be underestimated as much as 7 to 10 mm depending on the rotation of the femur when an AP radiograph is used for templating [20,21].

Intra-operatively, trialing of implants is utilized to assess hip center, femoral offset, and neck length. Range of motion testing with trial implants is then required to determine combined anteversion of the cup-stem construct. For optimum range and stability, combined anteversion should be between 35 and 45 degrees [22]. Trialing is also performed to assess for boney impingement tested at end flexion with internal rotation as well as at end extension with external rotation. All impinging osteophytes and excess bone must be removed to maximize hip range without impingement and levering. Leg lengths must also be checked. Soft tissues are lax with a shortened leg and this makes the hip more prone to dislocation.

Short neck sparing stems are a new concept to the modern design armamentarium of hip implants in North America [1,23]. European surgeons have been working with these stems since the early 1980's, beginning with the pioneering work of Pipino in Italy [1,11,12] (Figure 12). The majority of European neck-sparing stems are

Figure 12. Illustration of Pipino Style Neck-Sparing Stem. (Courtesy JISRF Archives)

novel in that they preserve the entire circumference of the femoral neck and the implants follow the native curve of the proximal femoral neck. In contrast, in North America the newer short stem designs are just truncated versions of conventional style stems that cut into the proximal femoral neck and still load the femur in the metadiaphyseal region. The advantages of using short neck-sparing implants are several. First, nearly all of the proximal bone is preserved. This is advantageous when revision surgery is required. Removing a neck sparing prosthesis is facile and the revision stem required is similar to using a conventional primary hip implant. More importantly, the exposure for the neck sparing prosthesis requires only small deep tissue releases, preserving the deep tissues. This allows for a more robust posterior soft tissue repair. This is key to minimizing hip dislocation with the posterior approach. Finally, hip offset and neck-length are easier to restore. The neck-sparing prosthesis follows the native curve of the femoral neck rather than fitting into the medullary canal of the femur. By following the femoral neck it is far easier to restore native femoral offset and neck length. This is a key advantage that we feel enhances hip stability. With this surgical technique it is easier to gauge soft tissue tension as there has been minimal releases of soft tissues compared to the larger style approaches and releases needed for implantation of conventional stem designs.

This study strengthens our commitment to utilizing a short curved neck-sparing stem when possible. Our overall dislocation rate was 0.88%, which is encouraging. Despite using this stem design in highly active patients, our overall stem revision rate is acceptable at 1.5%.

One caveat with this implant design is the use of the modular femoral neck. Even though much of the femoral neck was preserved we still used a modular proximal neck to fine tune offset and

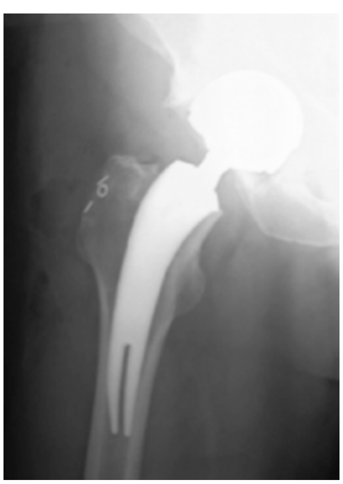

Figure 13. Postoperative X-Ray Showing ARC Stem with a Valgus Modular Neck Position. (Courtesy JISRF Archives)

Figure 14. Postoperative X-Ray Showing ARC Stem with a Neutral Modular Neck Position. (Courtesy JISRF Archives)

Figure 15. Postoperative X-Ray Showing ARC Stem with a Varus Modular Neck Position. (Courtesy JISRF Archives)

version (Figures 13, 14, & 15). Recent literature has cast disparaging results with modular necks in primary THA stems [24,25]. These reports impugn the modular neck junction as a source of debris from trapper junction abrasion, fretting and corrosion. This debris is a source for creating a toxic reactive synovitis that can ultimately lead to pseudotumor formation [26]. Biomechanical studies demonstrate that for every 1mm increase of lateral offset from hip center, there is a 8% increase in torque placed upon the modular neck junction. Furthermore, for every 1mm increase in vertical offset from hip center, there is a 6% increase in torque placed upon the modular neck junction (Figure 16a). Therefore, when using a conventional stem seated into the medullary diaphyseal canal, the modular neck junction is far from the

➢**Per 1mm increase in true lateral ball-center offset increases torque by 8%**

➢**Per 1mm increase of ball's neck-length increases torque by 6%**

Offset	Neck-Length	Nm
35 mm	49.50	84
40mm	56.58	96
45mm	63.65	108
50 mm	70.72	120
55 mm	77.79	132

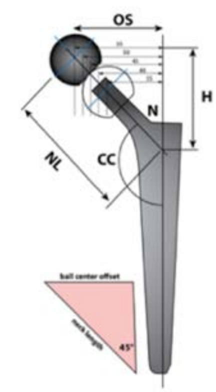

Figure 16a Chart Showing Torque Values for Femoral Offset and Neck Length. (Courtesy Ian Clarke)

hip center and torque forces upon the junction are high. In contrast, with the neck sparing hip prosthesis the modular neck junction, by virtue of preserving the femoral neck, is much closer to the hip center and modular neck stresses are significantly lower. This has been demonstrated in finite elemental analysis [27,29] (Figure 16b). This is also confirmed in this clinical study. In our 5 retrieved femoral stems we did not visualize any corrosion of the modular taper junction.

In summary, when using the neck sparing femoral stem we advocate head sizes between 32 to 36 mm. Neck skirts on the modular femoral heads are to be avoided at all costs. We do not recommend a modular head greater than 36mm

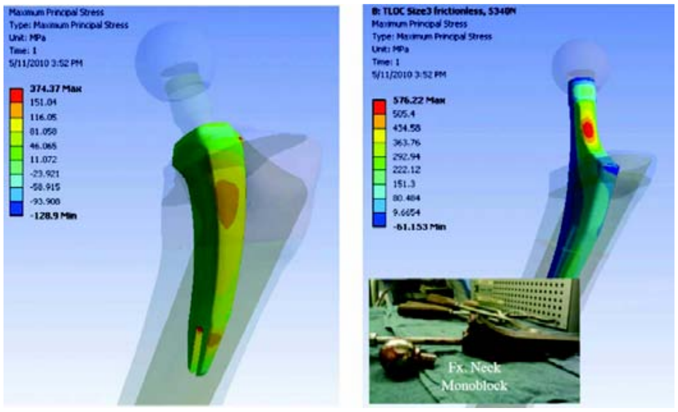

Figure 16b. FEA Model Showing 35% less Tensile Stress in the Neck-Sparing Stem versus that of a Tape-lock Style Stem. (Courtesy Declan Brazil)

as this can increase the torque loads upon the modular femoral neck junction. For small acetabular sockets, the dual articulation bearing is an acceptable alternative that provides a large head for stability. The majority of motion of the dual mobility construct is through the small 28mm ball and this reduces the torque stresses to the modular neck junction [28].

The advantage of proximal neck preservation with a neck-sparing stem is with the easy conversion to a standard diaphyseal engaging femoral stem if and when revision surgery is needed. We emphasize that there is a distinct learning curve to preparing and fitting a prosthesis in a completely intact femoral neck compared to a conventional diaphyseal engaging cementless stem. Preparation is fastidious and we strongly encourage the surgeon to attend a cadaver workshop and/or visit an experienced surgeon who is adept in this surgical procedure (Figure 17).

Figure 17. Postoperative X-Ray Showing Bilateral Hips. Left Showing a 1986 S-Rom Design and the Right Showing a 2010 ARC neck-Sparing Short Curved Stem Design. Both hips are in Place and Functioning Well. (Courtesy Keppler)

Disclosure Statement:

One or more of our authors have disclosed information that may present potential for conflict of interest with this work. For full disclosures refer to last page of this journal.

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