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A Comparison of Two Implant Systems in Restoration of Hip Geometry in Arthroplasty

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Abstract

Background Restoration of hip offset and leg length during THA is often limited by available implant geometries. The recent introduction of femoral components with a modular junction at the base of the neck (two modular junction components) has expanded the options to restore femoral offset and leg length.

Questions/purposes We asked (1) whether a femoral component with two modular junctions would predict by templating more frequent restoration of preoperative offset and leg length abnormalities than one with single modular junctions; and (2) how our use of these options compared with national sales data.

Patients and Methods We retrospectively reviewed the preoperative templating data in 100 primary THAs using single modular junction implants with only a neutral version stem and 100 THAs using two modular junction implants. We compared the frequency with which the desired leg length and offset were completely restored by preoperative templating in the two groups.

Results Offset and leg lengths were restored to within 1 mm in 85% of cases with two modular junction implants and 60% of cases with single modular junction implants. An anteverted or a retroverted neck was used in 25% of cases with the two modular junction stems. The national sales data revealed femoral neck components with version were used in 28% of cases.

Conclusions The use of a femoral component with two modular junctions resulted in more frequent ability to restore femoral offset and leg length than a single modular junction. The advantage of clinical flexibility should be tempered by the potential concerns of prosthetic mechanical failure (which has been reported in another implant system with two modular junctions), increased third-body wear and corrosive debris, and increased prosthetic cost.

Level of Evidence Level II, prognostic study. See Guidelines for Authors for a complete description of levels of evidence.

Introduction

Restoration of leg length and femoroacetabular offset is one of the primary technical goals for the surgeon during THA [5]. In so doing, abductor musculature function, hip stability, joint reactive force, and clinical equality of leg lengths can be more accurately restored [1, 8]. Preoperative templating can help achieve these goals [2, 11] by providing surgical guidelines such as level of femoral neck osteotomy and depth of acetabular reaming and suggested sizes of components. One must assume the surgeon will try to duplicate these technique guidelines intraoperatively as accurately as possible. The most accurate restoration occurs when the surgeon adheres meticulously to preoperative templating guidelines and does not rely on intraoperative subjective tests of leg lengths and offset such as the "shuck" tests [9]. The type of anesthesia (general or

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Each author certifies that his or her institution has approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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regional) also contributes to the inaccuracy of intraoperative subjective tests [9]. While templating preoperatively is currently the only reasonably accurate method by which to predict component sizes and placement, there are limitations. Radiographic technique variability, proximal femoral deformity, pelvic deformities, and external and flexion contractures of the hip all potentially can result in inaccurate measurements and sizing. In addition, limitations in femoral component neck length and offset options can make accurate restoration difficult.

Historically, femoral components were initially fabricated with a nonmodular femoral head and one neck option (length and offset), making restoration of offset and leg lengths difficult. Instability and abductor limp were common sequelae of such a construct when substantial loss of length or offset was encountered. The advent of modularity at the head–neck junction (singular modular junction [SMJ] component) allowed the use of a variety of head lengths and sizes. Subsequently, femoral components with differing neck offset were introduced in the form of "standard offset" and "extended offset" options. These femoral components provided isolated lateralization of the femoral component without lengthening of the leg. These developments expanded the surgeon's options to restore leg length and femoral offset. Recently, the development of femoral components with a modular junction at the base of the neck (two modular junction [TMJ] components) has further expanded the options to include the choice of a neutral, anteverted, or retroverted neck.

We asked (1) whether a femoral component with TMJs would predict by preoperative templating more frequent restoration of preoperative offset and leg length abnormalities than would one with a SMJ; and (2) how frequently the anteverted or retroverted neck options were used at our center compared with national utilization and if this frequency of utilization would justify the cost of additional prosthetic inventory.

Patients and Methods

We retrospectively compared preoperative templating data in all 100 primary THAs using a SMJ design and all 100 THAs using a TMJ design during calendar year 2008. The SMJ system used was the M/L Taper (Zimmer, Inc, Warsaw, IN), which has two different offset choices and five neck length options (one skirted), providing a total of 10 prosthetic options for a given stem size. The TMJ system used was the Kinectiv™ (Zimmer, Inc), which possesses a taper junction for the head as in the M/L Taper and a modular junction at the base of the neck. Each stem has five offset options (extra extended, extended, standard, reduced, extra reduced), five neck length options and offset combinations (−8 mm, −4 mm, 0 mm, +4 mm, +8 mm), and anteverted, neutral, or retroverted options. This provided 60 total prosthetic options for a given stem size (not all necks have all options). We had prior IRB approval for the study.

All templating was performed on standard radiographs; no digital radiographs or digital templating were performed. All cases were manually templated preoperatively using a standard technique by a single observer (REW). One report suggests there is no difference if the preoperative planning is performed by a senior or more junior surgeon [2]. The leg length discrepancy was determined using the AP pelvic view centered on the symphysis pubis. All cases had adequate radiographs. The interischial line was used as the reference to which the relative location of the lesser tuberosity on both sides was compared. While this can be occasionally misleading secondary to deformity or flexion contracture, we performed this with the greatest accuracy possible. Using the AP pelvic view, the location and size of the acetabular component were templated and the center of rotation marked. We then used this same view to template the size and location of the femoral component. We attempted to completely correct preoperative offset and leg length abnormalities by selection from prosthetic options and calculation of the level of the femoral neck osteotomy. The femoral component template was placed at a level to restore desired length with the component of appropriate size. This was then marked as the osteotomy level. We then recorded on a standard card used during surgery the anticipated size of components, the femoral neck osteotomy level as measured above the lesser trochanter, the anticipated neck offset, and the anticipated head size and length.

We identified the frequency with which the desired leg length and offset were completely restored as predicted by preoperative templating in both groups. For offset to be rated as completely restored, the center of rotation of the proposed femoral component had to be superimposed over the center of rotation of the acetabular component. For leg lengths to be equalized, the center of rotation of the femoral head had to be cephalad to the center of rotation of the acetabular component by the predicted leg length difference as described above. To be completely restored, the templating had to result in less than 1 mm of complete correction of both offset and leg lengths. This criterion was arbitrarily chosen for this templating study and was not meant to have any predictive value of clinical importance of any specific amount of residual lack of correction of either offset or leg lengths. The position of the acetabular component was not changed to assist in the correction of these two parameters, a maneuver occasionally used in the past when fewer femoral options were available. In such a situation, the acetabular component may have been left slightly lateralized to restore additional offset.

We reviewed the operative reports of the TMJ cases only to determine the usage of the anteverted or retroverted option. This was an intraoperative decision to improve stability and/or ROM [6, 10]. This option is not available in the SMJ system. With our templating protocol, the need for a retroverted or anteverted option is not predicted.

To compare our usage of the version option to the national experience, we obtained national sales data from the implant manufacturer (Zimmer, Inc, personal communication; sales data on file) for the first 11,000 units sold in the United States for five business quarters (Quarter 1 2008 to Quarter 1 2009).

Results

In the SMJ group we obtained restoration of both offset and leg length in 60 patients (60%) and incomplete restoration in 40 (40%). In the TMJ group we obtained restoration of both offset and leg length in 85 patients (85%) and incomplete restoration in 15 (15%).

When the TMJ implant was used, the surgeon chose an anteverted or retroverted femoral neck option in 25 patients (25%).

The national sales data revealed two interesting findings (Zimmer, Inc, personal communication; sales data on file). For the M/L Taper, standard offset was used in 69.2% of sales and extended offset 30.8%. For the Kinectiv^{TM}, 72% were straight necks and 28% were anteverted or retroverted. The sales data did not allow us to differentiate whether the version option was used in an anteverted or retroverted orientation. The M/L Taper did not allow an anteverted or retroverted option.

Discussion

Restoration of femoral–acetabular offset and leg lengths are accepted reconstructive goals of THA [1, 5]. However, limitations in femoral component neck length and offset options can make complete restoration difficult. Recently, the development of femoral components with a modular junction at the base of the neck has further expanded the options available to achieve accurate restoration of the hip. We asked (1) whether a femoral component with TMJs would predict by preoperative templating more frequent complete restoration of preoperative offset and leg length abnormalities than would one with a SMJ; and (2) how frequently the anteverted or retroverted neck options were used at our center compared with national utilization and if this frequency of utilization would justify the cost of additional prosthetic inventory.

We acknowledge limitations to our study. First, this is a templating study with no clinical evaluation of patient function or implant durability. Second, the templating was performed by only one of the authors and no interobserver variability was determined. Third, while templating the radiographs we did not take into consideration any fixed flexion deformities or technique limitations. We, however, do not believe these limitations jeopardize our conclusions for the following reasons: (1) the ability to accurately execute the templated plan should not differ between groups or be affected by the implant choice; and (2) templating was performed by an individual experienced in the technique. Fourth, we used radiographs that were the best we could possibly obtain for each patient in clinical practice. No specific fixed deformity was noted in either group. No radiographic technique variation or limitations were noted.

The TMJ system has 60 possible prosthetic combinations for a given stem size compared with 10 possible prosthetic combinations for the SMJ system. The main advantage of this increased number of combinations is the potential to more frequently completely restore offset and leg lengths. This templating study confirmed this advantage. The TMJ system completely corrected both offset and leg lengths in 85% of cases, while the SMJ system corrected completely only 60%. An identical study with different implant systems showed contradictory results in that a TMJ system and a SMJ system showed an equal percentage of complete or exact correction of both offset and leg lengths. This study used digital radiographs and digital templating [2].

The options of an anteverted or retroverted neck in the TMJ system allows the surgeon to improve ROM and/or prevent impingement. Our TMJ cases showed a 25% utilization of this option, which was comparable to the national utilization of 28%.

An important concept for future study is the determination of how much postoperative residual lack of offset or leg length correction is clinically important. Increased trochanteric pain has been proposed as a result of overcorrection of offset. Iorio et al. [4] however showed no increase in pain in lateral trochanteric pain related to offset. The lack of correction has theoretical biomechanical disadvantages [1], but how much lack of correction of offset is important has not been determined. The lack of correction or excessive lengthening has been extensively studied [3, 5, 7]. These studies all confirm excessive lengthening of greater than 10 mm is often remarkably well-tolerated by patients, but some patients do not tolerate excessive lengthening of only 3 to 5 mm. Lack of complete correction of leg lengths can be managed by a shoe lift if symptomatic but is not ideal from the patient's perspective.

Complete correction of both offset and leg length is certainly the goal in most cases.

A higher percentage of predicted complete correction of offset and leg lengths and the version option should make the TMJ systems more attractive to the surgeon. However, these clinical advantages should be considered in light of potential mechanical problems and the increased costs of a TMJ system. The addition of modular junctions provides the potential for additional corrosive debris and mechanical failure at the higher cantilever stress interface at the more distal of the two junctions. A similar design reported 35 modular neck fractures, which occurred in long necks with substantial offset increases [13]. The majority were in heavy, active male patients. Mechanical testing data meeting acceptable strength standards are critical for this type of design. Modular junction corrosive changes have been reported as well [12]. This potentially provides additional particulates that can lead to osteolysis or third-body wear scenarios. The presence of TMJs may double this debris load compared with only a SMJ. Longer clinical followup is necessary to address these potentially concerning clinical issues.

Currently, the cost of implanted devices has become more of a concern for hospitals and surgeons. There is generally a 20% premium cost for the Kinectiv^{TM} (TMJ) when compared with the M/L Taper (SMJ) (Zimmer, Inc, personal communication; sales data on file).

The availability of femoral component implant systems with TMJs allows surgeons to more completely restore anatomic parameters. This concept also allows intraoperative improvement in ROM, impingement, and stability by either increasing or decreasing version. Careful evaluation of all issues is suggested before routine adoption of a TMJ system.

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