VOLUME 7 • NUMBER 1 March 2017

Reconstructive REVIEW

An Open Access Journal

OFFICIAL JOURNAL OF THE

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VOLUME 7 • NUMBER 1 March 2017

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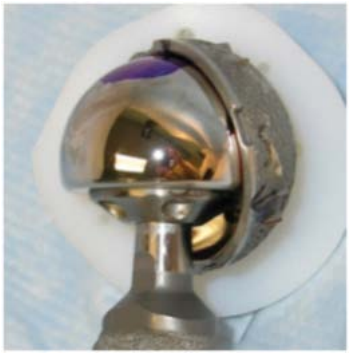

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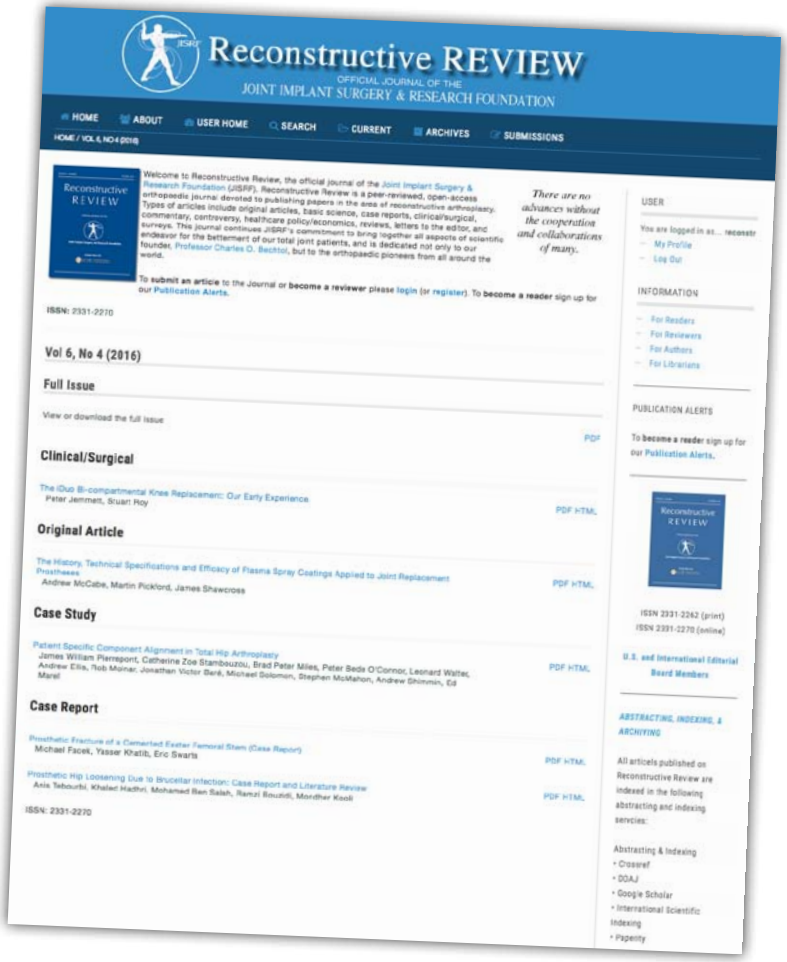

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Leg and Femoral Neck Length Evaluation Using an Anterior Capsule Preservation Technique in Primary Direct Anterior Approach Total Hip Arthroplasty

Nelson S[1], Adrados M[1], Gala R[1], Geiger E[1], Webb M[1], Rubin L[1], Keggi K[1]

Abstract

Background: Achieving correct leg and femoral neck lengths remains a challenge during total hip arthroplasty (THA). Several methods for intraoperative evaluation and restoration of leg length have been proposed, and each has inaccuracies and shortcomings. Both the supine positioning of a patient on the operating table during the direct anterior approach (DAA) THA and the preservation of the anterior capsule tissue are simple, readily available, and cost-effective strategies that can lend themselves well as potential solutions to this problem.

Technique: The joint replacement is performed through a longitudinal incision (capsulotomy) of the anterior hip joint capsule, and release of the capsular insertion from the femoral intertrochanteric line. As trial components of the prosthesis are placed, the position of the released distal capsule in relationship to its original insertion line is an excellent guide to leg length gained, lost, or left unchanged.

Methods: The radiographs of 80 consecutive primary THAs were reviewed which utilized anterior capsule preservation and direct capsular measurement as a means of assessing change in leg/femoral neck length. Preoperatively, the operative legs were 2.81 +/- 8.5 mm (SD) shorter than the nonoperative leg (range: 17.7 mm longer to 34.1 mm shorter). Postoperatively, the operative legs were 1.05 +/- 5.64 mm (SD) longer than the nonoperative leg (range: 14.9 mm longer to 13.7 mm shorter).

Conclusion: The preservation and re-assessment of the native anterior hip capsule in relationship to its point of release on the femur is a simple and effective means of determining leg/femoral neck length during DAA THA.

Keywords: *total hip arthroplasty; leg length discrepancy; femoral neck length; direct anterior approach; hip capsule; capsulotomy; capsulectomy; capsulorrhaphy*
Level of Evidence: *AAOS Therapeutic Level IV*

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Introduction

Maintaining both hip stability and appropriate leg lengths is one of the great challenges of total hip arthroplasty (THA). Incorrect leg length is a major cause of morbidity after THA and has been associated with back pain, sciatica, neuritis, gait disorders, general dissatisfaction, early loosening of components and revision surgery [1-7]. Additionally, patients who perceive leg length discrepancy have been found to have worse Oxford Hip scores. [8,9] With such morbidity, LLD is second only to nerve injury as the most common cause of litigation after THA [10]. As such, the potential for iatrogenic leg length discrepancy is a known risk of THA that should be discussed with patients before surgery and documented accordingly, explaining that a minor increase in leg length is not uncommon and perhaps preferable to a dislocated hip.

Preoperative assessment and implant templating are important considerations. Templating is an important guide to intraoperative decision-making, but excellent planning does not guarantee excellent execution [11]. Actual sizing of implanted components has been reported to match preoperative templating in only 60% of cases [12], and therefore should not be relied upon as the only means of determining leg or femoral neck length.

There have been over 20 intraoperative methods described for evaluating limb length and include the Ober test, the shuck test, and the drop kick test [13,14]. These methods utilize soft tissue tension with components in place as an indicator for limb length, but anesthesia induced muscle relaxation may limit the trustworthiness of these tests. Direct leg-to-leg comparison can also be useful but the palpation of anatomic landmarks may be inaccurate under surgical drapes, especially during lateral decubitus patient positioning for THA.

Fluoroscopically guided THA has increased in popularity recently, as it can ensure correct component position radiographically and may facilitate proper leg lengths. However, this method potentially adds operative time, requires both a radiolucent table and an image intensifier, and may increase required personnel and equipment traffic, all of which can carry an increased risk of wound contamination and surgical site infection. The additional radiation exposure to patient and staff is also a matter to consider [15].

Intraoperative navigation and length measurement techniques are usually based on 2 reference points marked on the pelvis and femur. This can be achieved via iliac fixation pins, intraoperative calipers, infracotyloid pins, or fixed suture lengths [16]. None of these methods are perfect, and many inconsistencies have been described [11].

Computer navigation and robot assisted surgery have also been developed to reconstruct normal anatomy and proper leg length. However, these methods are expensive, not widely available, and do not address the key issue of restoring soft tissue tension. For the present, they pale to the intraoperative judgement of an experienced surgeon.

The senior author and his colleagues have used the anterior, internervous, muscle-sparing surgical approach since 1973, in some 15,000 primary and revision hip arthroplasties [17-19]. This anterior approach was presented as a scientific exhibit at the Annual Meeting of the American Academy of Orthopaedic Surgeons (AAOS) in 1977, and published in 1980 [17]. During the first 30 years of his work with the DAA, a total or subtotal capsulectomy was the norm. The results were satisfactory, but to more accurately restore leg length and attempt to further increase joint stability, a technique for anterior hip capsulotomy with anatomic capsule preservation, whenever possible, was evolved. It has helped to decrease soft tissue dissection, reduce the dead space created by a capsulectomy, and has the additional benefit of allowing for the intraoperative assessment of leg/femoral neck length, as is described within this paper.

Surgical Technique

With the patient supine on the operating table, a short oblique incision is made distal and lateral to the anterior superior iliac spine overlying the femoral neck. The medial border of the tensor fascia lata muscle is identified. The muscle and its fascia are then split longitudinally, approximately 1 cm lateral to its medial border. The medial strip of fascia and muscle can add to safety by protecting the small branches of the lateral femoral cutaneous nerve and the femoral neurovascular bundle. Cobra retractors are then placed on the superior and inferior aspects of the hip capsule. The superior Cobra retracts the tensor fascia lata and the abductors. The inferior Cobra retracts the rectus, sartorius, and iliopsoas. These two Cobras provide excellent exposure of the anterior hip capsule, which can then be further defined by the removal of its overlying fatty tissues.

An assessment is then made if further capsular visualization is necessary, which can be achieved by dissection with elevation and/or release of the reflected head of the rectus femoris by the proximal placement of a third blunt Cobra under its fibrous tendon with the tip of the Cobra in place over the anterior acetabulum with the tip just over the anterior rim of pelvis. In most cases of elderly patients without excessive acetabular or femoral head osteophytes and an atrophied reflected rectus, this third Cobra is not necessary and the capsule can be incised by starting the

incision underneath the tendon, but the morphology of the reflected head can be larger and more muscular, particularly in younger males.

The exposed anterior capsule is incised in line with the long axis of the underlying femoral neck, and released from its distal lateral insertion on the intertrochanteric line (Figure 1). If necessary and if it is tight, the medial distal portion can also be released, creating an inverted T-capsulotomy. The two Cobras are then placed inside of the capsule on the superior and inferior portions of the femoral neck. The pre-planned base of the femoral neck cut is then performed, the femoral head removed, the acetabulum prepared, and the prosthetic components inserted. Depending on the exposure and mobilization needed, more, or all, of the femoral capsule can be dissected and released, yet preserved for subsequent repair. The placement of the components can be performed in a variety of ways, ranging from their insertion without any trial components, to total fluoroscopic control. Based on our surgical experience, excellent visualization of the hip and the anatomical position of the patient's spine, pelvis, and legs, we rarely use trial components other than femoral heads, but recommend them if there is any question about achieving satisfactory component position.

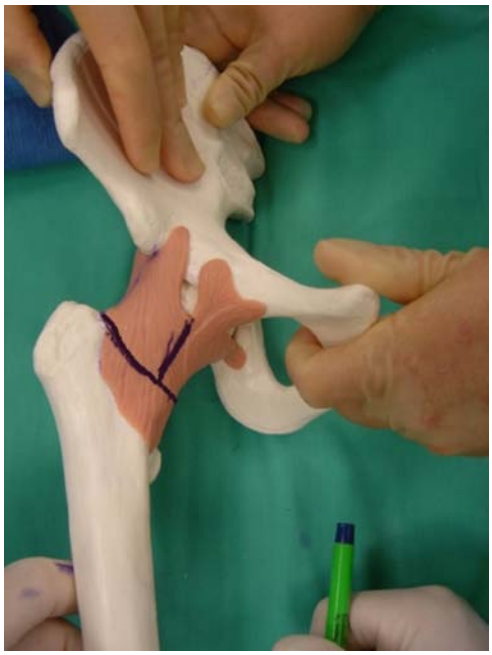

Figure 1. Planned capsular incisions performed during the DAA to THA. (Image courtesy of Kristaps J. Keggi, MD)

After the trial femoral head is placed, femoral neck length is then assessed by approximation of the hip capsule to the distal intertrochanteric line with the leg held in a neutral position, with slight flexion and internal rotation (Figure 2). If the capsule overhangs its release point on the intertrochanteric line, then the pre-operative limb/femoral neck length has been shortened. If the capsule does not reach the point where it was released, then the limb/femoral neck has been lengthened by the components.

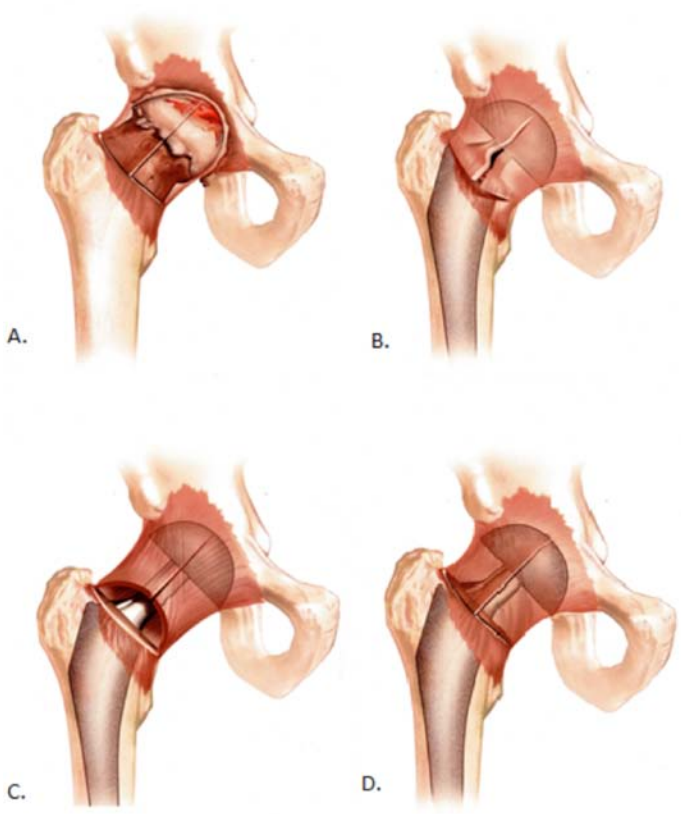

Figure 2. Illustrations demonstrating capsule position when assessing leg length. Illustration A demonstrates the native capsule position after capsulotomy. In illustration B, the capsule overhangs its site of release along the intertrochanteric line demonstrating that the leg is shorter than it was pre-operatively. Illustration C demonstrates a gap between the proximal and distal capsular limbs, indicating the leg has been lengthened. Illustration D shows the capsule position to be unchanged. (Illustration by Genevra Garrett)

Thus, a simple look at the restored position of the released capsule will allow the selection of the final femoral head to be used to achieve the leg length correction determined by the pre-operative x-rays. Intrinsic kinematic stability of the THA is of paramount importance, and it must be tested by putting the hip through a complete arcs of motion. This can only be achieved when no traction table is used, because the leg is draped free and can be moved in all planes during the procedure to test a full range of motion and ensure there is no impingement or subluxation during the procedure prior to closure. If the joint is found to be unstable, the instability can then be corrected by an increase of the neck length by a few millimeters, or upsizing the head and liner diameter, which can be the alternative to more extreme surgical measures.

Methods

After obtaining IRB approval to perform a medical record review, the records database was queried for primary, unilateral total hip arthroplasty (CPT 27130) performed between 2011 and 2012. A retrospective review was performed and radiographs of 80 consecutive patients with complete preoperative and postoperative images were reviewed on the radiology program PACS (Picture Archiving and Communication System). Direct capsular measurement was the primary determinant of leg length in these patients. For radiographic review, a line was drawn between the base of the teardrops and the vertical distance between this line and the lesser trochanters was measured for both the operative and nonoperative legs (Figure 3). Limb lengths were recorded in millimeters and analyzed using Microsoft Excel (Redmond, Washington, USA).

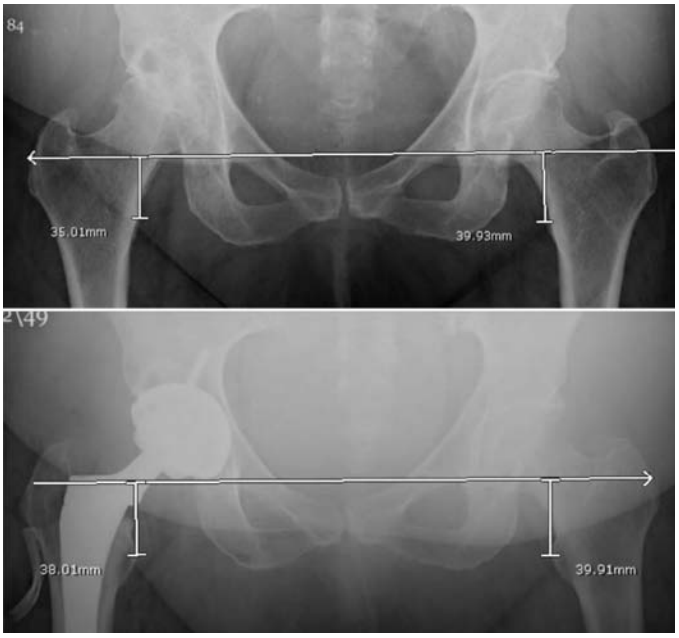

Figure 3. Patient radiographs demonstrating preoperative limb shortening due to destruction of cartilage and subchondral bone and postoperative reproduction of hip length to less than a millimeter.

Exclusion criteria included cases performed with a simultaneous bilateral technique, cases with incomplete records or radiographs, or cases with severe deformity. More specifically in cases involving major deformities, bone loss, or severe flexion contractures, we would expect a pathologically contracted, adherent, and compromised anterior capsule that is best managed with a radical capsulectomy during the procedure, precluding the use of a routine capsulotomy.

Results and Discussion

Preoperatively, many patients are shorter on the affected side due to cartilage destruction and bone remodeling secondary to the disease process. On average, our results revealed that preoperatively, the operative legs were 2.81 +/- 8.5 mm (SD) shorter than the nonoperative leg (range 17.7 mm longer to 34.1 mm shorter). Postoperatively, the operative legs were 1.05 +/- 5.64 mm (SD) longer than the nonoperative leg (range 14.9 mm longer to 13.7 mm shorter) (Table 1). Seven patients had a postoperative hip height discrepancy of greater than 10 mm, however each of these patients had a similar discrepancy of over 10 mm preoperatively (Figure 4). Preoperative deformity, component choice, and implant position were taken into consideration for these patients in an effort to not over correct. Leg length equality was sought in every case unless it sacrificed hip stability or would alter an otherwise compensated pelvic balance in those patients with a concurrent fixed scoliotic deformity.

Table 1. Patient demographics and limb length discrepancies

Male	36 (45%)
Age (SD)	67 (+/- 12.4)
Left leg surgery	32 (40%)
Preoperative limb length discrepancy (SD)	-2.81 (+/- 8.50) mm
Postoperative limb length discrepancy (SD)	1.05 (+/- 5.64) mm

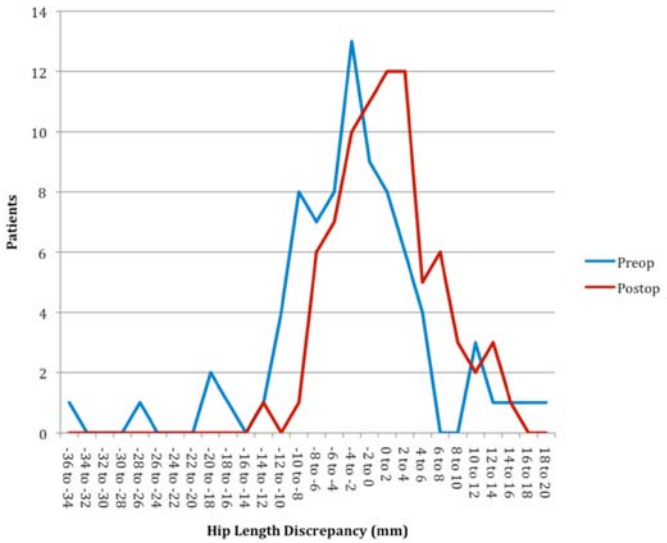

Figure 4. Frequencies of hip length discrepancies preoperatively and postoperatively.

Several novel alternative methods for assessing femoral neck length have been described including comparing the trial head and neck implants with the osteotomized femoral head using visual assessment [20]. Similar to anterior capsule assessment, this method may also be expeditious, and

cost-effective, but may require additional equipment or specialized measurement jig. In general during our cases, a second subcapital osteotomy is created in addition to the primary basicervical osteotomy, creating a "napkin ring" cut of femoral neck bone. Thus, to measure the excised head and neck, one would need to place these together with two free saw blades to gain an accurate measurement, which is objective, but perhaps more subjectively difficult to assess than our capsular assessment as described within this paper.

A number of technical factors have been associated with leg length discrepancy, including uncemented femoral stems [21]. All patients in this evaluation underwent THA with uncemented components. The direct anterior approach for THA with a capsular sparing lends itself well to component positioning and the achievement of consistent, accurate leg length restoration.

Other potential benefits of capsular repair include increased stability and infection protection. To our knowledge, no studies have examined the stability augmented by capsular repair of THA performed through the DAA, however, Hughes et al. examined the effect of capsular repair in cadavers following hip hemiarthroplasty through a direct lateral approach and found that capsular repair required a 4-fold higher peak torque force to dislocate anteriorly [22]. Infection reduction in capsular repair has also not been directly evaluated, however, preserving additional anatomic layers might assist in microbial blockade.

In cases of major deformities, bone loss, or severe flexion contractures with compromised anterior capsules, the method we have described to "fine tune" the average hip to a few millimeters will not apply and the selection of prosthetic components and femoral heads to achieve optimum leg length and joint stability will depend on x-rays, operative findings and clinical judgment.

This paper discusses a novel technique for assessment of leg length discrepancy after THA and provides objective numerical analysis to support the accuracy of this technique at our institution. The limitations of this article include the small size of its series and that all cases were performed by a single surgeon at a single institution. Additionally, radiographs were not standardized and there may be small differences in magnification and rotation among the plain films. Due to variances in rotation of the images, we were unable to assess femoral offset which is critical to stability and abductor function, which enhance hip function after THA [23].

Notably, this is a retrospective evaluation, and thus multiple factors aside from capsular measurement were likely used for intraoperative evaluation of leg length; most notably these included the surgeon's assessment of hip stability, shuck, and intra-operative use of the medial malleoli to measure the operative limb to the non-operative limb during the supine DAA. Future prospective evaluations comparing the various intraoperative assessments of leg length are thus necessary to determine the most accurate and reproducible method from among these options to produce reliable leg length equality. In addition, comparison of the capsular preservation technique described here to technologies such as fluoroscopy or navigation guidance would lend additional insight to this topic in the future.

Disclosure

The authors declare that there is no conflict of interest regarding the publication of this paper. For full disclosures refer to last page of this journal.

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Diagnosing and Treating Popliteal Tendinopathy After Total Knee Arthroplasty

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Abstract

The following office tip describes four patients that underwent primary total knee arthroplasty and developed posterolateral knee pain at a mean follow-up duration of 1.6 months postoperatively. The first patient in this series noted substantial pain lying in bed (in a lateral decubitus position with the operative leg up) while attempting to abduct her leg to adjust her sheet in bed. A thorough clinical and radiographic work-up was performed. This patient's posturing in bed (and subsequent physical exam maneuver) led to a presumptive diagnosis of popliteal tendinopathy. The diagnosis was confirmed arthroscopically by identifying a frayed and inflamed popliteal tendon. After undergoing arthroscopic popliteal tendon release, the patient noted complete pain relief while retaining coronal stability in both flexion and extension. The following office tip defines a previously undescribed clinical diagnostic examination for popliteal tendinopathy that was identified based on a patient's symptomatology and subsequently utilized to identify three additional cases of arthroscopically confirmed popliteal tendinopathy.

Keywords: *total knee arthroplasty; popliteal tendinosis; popliteal tendonitis; tendinopathy; posterolateral knee pain*
Level of Evidence: *AAOS Therapeutic Level IV*

Introduction

Pain following primary total knee arthroplasty (TKA) is unfortunately a common finding [1]. There are numerous causes for a painful TKA, which make diagnosing the source of the pain even more challenging [2,3]. Popliteal tendinopathy is an uncommon cause of pain, which can present with posterolateral knee pain, often associated with motion-induced crepitus in the region of the popliteal tendon. The first description of popliteal tendon dysfunction during primary TKA was noted intraoperatively at the time of capsular closure [4]. The authors noted a "popping" that occurred during flexion and extension. After release of the popliteal tendon, they noted that the "popping" disappeared and that the knee was stable. Since this study, Insall et. al.

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proposed arthroscopic popliteal tendon release for patients diagnosed with popliteal tendon dysfunction following primary TKA [5]. However, to our knowledge, other than the presence of patient-reported posterolateral discomfort, we are unaware of any single clinical examination maneuver to precisely diagnose popliteal tendinopathy following primary TKA. The following office tip describes a clinical examination maneuver utilized to diagnose four patients with popliteal tendinopathy, and secondarily confirmed at the time of arthroscopic release of the popliteal tendon.

Office Tip

The diagnosis of post-operative popliteal tendinopathy following total knee arthroplasty can be made with a simple clinical test. Each case of popliteal tendinopathy was confirmed arthroscopically and after release of the tendon, resulted in complete relief of symptoms.

Case Examples

All but one of the patients in this series underwent primary TKA by one of the senior authors at a single institution. The primary TKA was performed utilizing a gap balancing approach with a posterior stabilized mobile bearing Attune TKA (Warsaw, IN). The postoperative course was uneventful in each case. However, approximately 2 months postoperatively, the first patient in this series presented with posterolateral knee pain. This patient was a 70 year old female with a preoperative diagnosis of osteoarthritis of her right knee. Preoperative radiographs of her right knee demonstrated tricompartmental arthritis and chondrocalcinosis (Figure 1). Postoperative radiographs of her right knee demonstrated a well-fixed, well-aligned TKA without evidence of loosening, lysis, lateral overhanging femoral component, or lateral femoral osteophytes (Figure 2).

During her clinical evaluation, she localized the pain to the posterolateral aspect of her knee, and noted no significant pain when ambulating or sitting. Her pain could not be reproduced on clinical examination, although the posterolateral aspect was diffusely painful to palpation. Interestingly, she noted substantial pain lying in a lateral decubitus position in bed with the operative extremity up when abducting her leg while attempting to adjust the bed sheets (Figure 3). Repeat of this maneuver consistently repro-

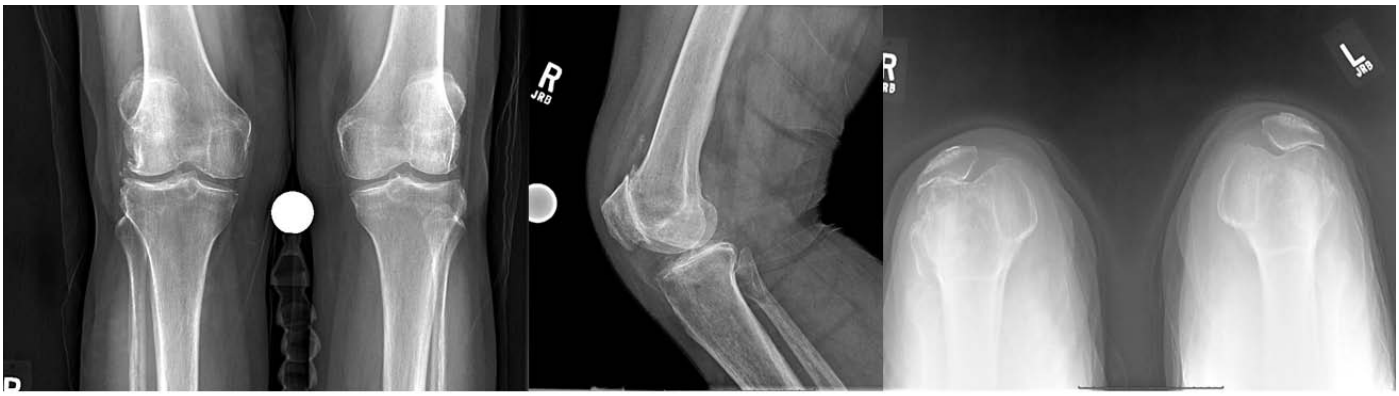

Figure 1. AP, lateral and patellar view of the right knee demonstrates severe patellofemoral arthritis with chondrocalcinosis.

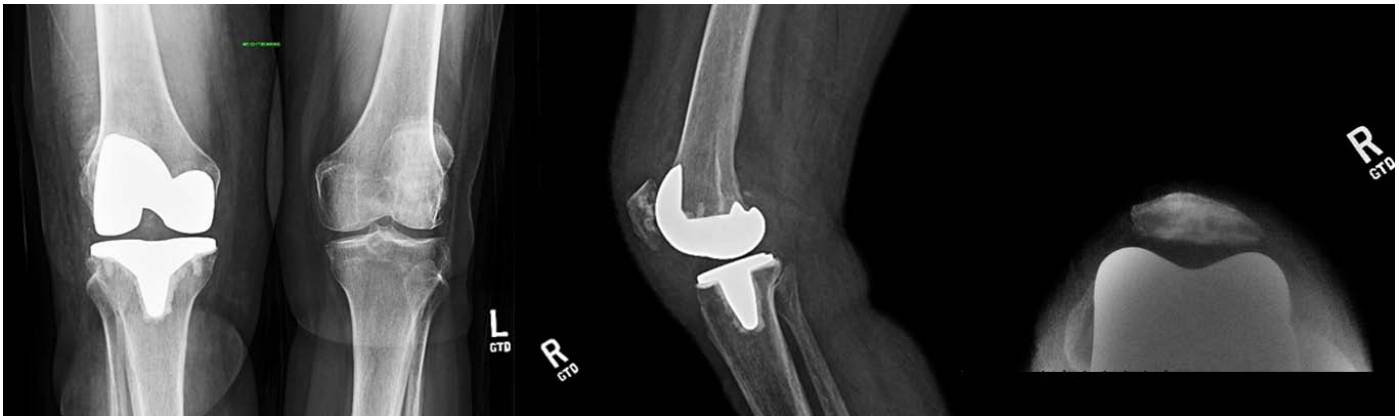

Figure 2. Postoperative AP and patellar view demonstrate a well-fixed well-aligned right total knee arthroplasty. There does not appear to be evidence of lateral femoral osteophytes or femoral component overhang.

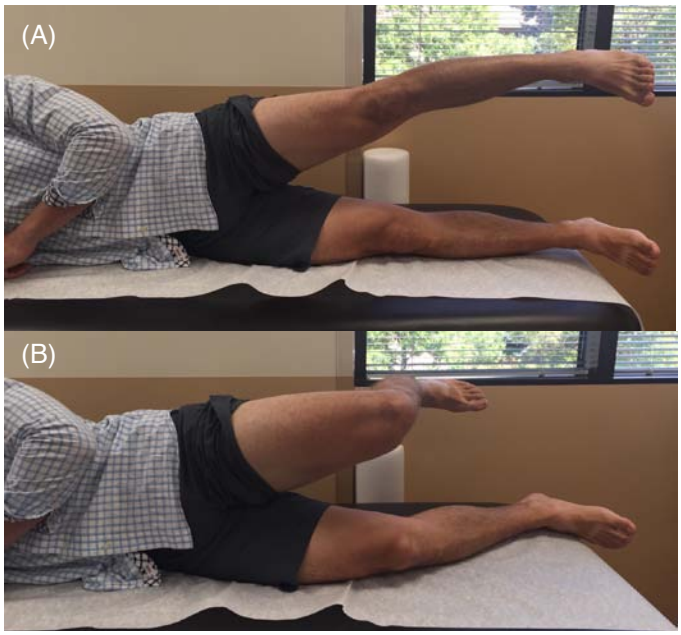

Figure 3. The above clinical photographs demonstrate the clinical exam maneuver for diagnosing popliteal tendonitis. (A) The patient is placed in a lateral decubitus position with the operative extremity up. The patient then abducts their hip against gravity resistance with their knee in full extension. (B) With their hip abducted the patient flexion their knee from 0 to 90 degrees.

duced the posterolateral pain. This position applied a varus stress to a flexed knee, a position where the popliteal tendon acts an important static restraint in varus stability [6]. Therefore, it was hypothesized that this maneuver could be utilized to assess for popliteal tendinopathy in the setting of TKA. The patient was treated with conservative measures including activity modification, icing, and NSAID use for three months with continued pain.

After discussing the proposed mechanism for posterolateral pain to this patient, an arthroscopic release of the popliteal tendon was recommended and performed seven months after primary TKA. Intraoperatively, the popliteal tendon was visualized and noted to have substantial tendonitis, fraying, and was shown to impinge slightly on the femoral component of the TKA (Figure 4). Utilizing the arthrosopic shaver, the popliteal tendon was released without any additional procedures performed.

After the arthroscopic popliteal tendon release, the patient noted complete relief of her posterolateral pain within 48 hours following the operative procedure. On her most recent clinical appointment, six months after surgery, she was noted to have complete resolution of her pain. Additionally, her knee was stable to varus and valgus stresses in flexion and extension. Her radiographs demonstrated no change, with continued excellent alignment and no evidence of radiolucencies or lysis.

Since the first patient presentation, three additional patients presented with similar posterolateral knee pain. Utilizing the clinical examination maneuver described above with a varus stress applied to the patient's operative extremity in a lateral decubitus position, each patient's pain was readily reproduced. The average duration from TKA to the diagnosis of popliteal tendonitis was 1.6 months. The arthroscopic findings in each patient were diagnostic of popliteal tendinopathy. Subsequently, all patients noted complete or near complete resolution of their pain without any evidence of coronal or sagittal instability identified at final follow-up.

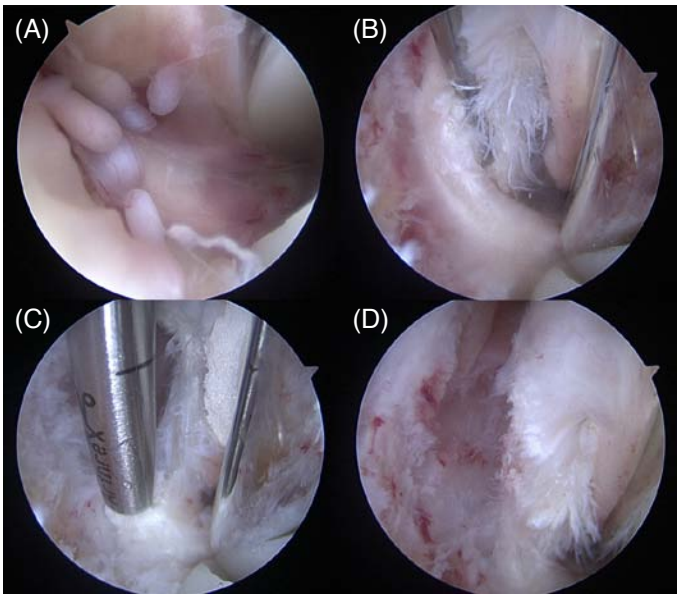

Figure 4. Arhtroscopic views of the right knee. A: The lateral compartment of the right demonstrates substantial synovitis and (B) fraying of the popliteal tendon. C: The arthroscopic shaver is utilized to resect the popliteal tendon. D: The popliteal tendon has been completely released.

Discussion

Postoperative knee pain following primary TKA is unfortunately a common finding [1]. Furthermore, identifying the source of pain can occasionally be a diagnostic dilemma due to the wide variety of pathologies that can lead to knee pain in this patient population [2,3,7]. One uncommon source of postoperative knee pain is popliteal tendinopathy [5]. Although there have been case reports describing treatments for popliteal tendon dysfunction, little is known about how to best identify this clinical condition precisely [4]. To our knowledge, a diagnostic clinical examination maneuver for popliteal tendinopathy following TKA has yet to be described prior to this study. Therefore, the following case series describes a unique clinical technique of identifying popliteal tendon dysfunction with sub-

sequent arthroscopic confirmation of the diagnosis. Additionally, a short-term clinical and radiographic follow-up was performed on this patient population to ensure resolution of symptoms.

The proposed diagnostic maneuver requires the patient to lie supine with their operative extremity elevated. The examiner then has the patient abduct the operative extremity while an adduction force is applied to the lower leg close to the ankle joint. This force results in a varus stress through the knee. As was discussed previously, the popliteal tendon is an important varus stabilizer in knee flexion [6]. Therefore, this clinical test appears to specifically stress the popliteal tendon. Each patient in this series had nonspecific posterolateral knee pain, which could not be reliably reproduced with common clinical examination maneuvers that apply varus and valgus stresses in flexion and extension. After discovering this maneuver during the first patient encounter in this series, all subsequent patients stated that their pain was reliably reproduced.

The source for popliteal tendinopathy has been attributed to a retained lateral femoral condylar osteophyte or posterior femoral component impingement, often associated with excessive lateral positioning of the femoral component beyond the osseous perimeter of the lateral femoral condyle [5]. Both of these conditions can increase tension on the traversing popliteal tendon resulting in irritation. Additionally, arthroscopic release of the popliteal tendon was proposed as a standard treatment for patients diagnosed with popliteal tendinopathy [8]. The release of the tendon in this patient population was not associated with an increase in instability and had reliable pain relief. However, a recent study demonstrated a decrease in patient outcomes at two to three years postoperatively in a cohort of 15 patients that had accidental iatrogenic intraoperative popliteal tendon release [9]. Although assessing a different outcome, these results appear to differ from Kesman et. al., who prospectively enrolled eighteen patients to randomly have their popliteal tendon released by the first assistant, while the senior surgeon was blinded to the presence or absence of the release [10]. The senior surgeon, with trials in place, would assess ligamentous stability. No subjective difference in static stability was noted between the two cohorts. It is possible that the arthroscopic release and the intraoperative isolated release of the popliteus tendon are more precise methods for releasing the popliteal tendon. Whereas the iatrogenic, saw blade release, of the popliteal tendon could potentially release the posterolateral corner of the knee resulting in worse outcomes. However, longer outcomes are necessary to determine if an arthroscopic release of the popliteal tendon will impact patient outcomes.

There are several notable limitations to the following study. First, this was a retrospective case series, and therefore has inherent limitations of both the study design and the small patient population. However, we still believe this diagnostic maneuver is useful in identifying popliteal tendinopathy, an uncommon cause of postoperative knee pain. Second, this clinical test has not been validated or compared to other diagnostic tests. Therefore the diagnostic accuracy is unknown. Although we did note arthroscopic evidence of popliteal tendinopathy and complete pain relief after release in each patient, a comparative study including imaging and other exam maneuvers to determine the validity of this exam are warranted. Third, it is possible that each patient's tendinopathy may have resolved without surgical treatment. Future studies should be centered on the natural progression of popliteal tendinopathy after total knee arthroplasty which may help direct the timing of surgical intervention in this patient population. Finally, long-term clinical follow-up is necessary to determine if there are any clinical consequences of popliteal tendon release. As was discussed previously, one study noted worse outcomes in patients that had iatrogenic popliteal tendon release during primary TKA [9]. This may represent a posterolateral corner release and therefore may not be generalizable to the isolated popliteal tendon release noted in this study.

Summary

The following study demonstrates a clinical examination method for diagnosing popliteal tendon dysfunction. This exam was performed on four patients in this series and the diagnosis of popliteal tendinopathy was confirmed arthroscopically in each case. An arthroscopic popliteal tendon release was subsequently performed and resulted in complete pain relief in all patients. Additionally, no postoperative instability was identified. This clinical examination should be considered and utilized when confronting the common diagnostic dilemma of a painful TKA, especially posterolateral knee pain that is difficult to reproduce clinically.

Disclosure

The authors declare that there is no conflict of interest regarding the publication of this paper. For full disclosures refer to last page of this journal.

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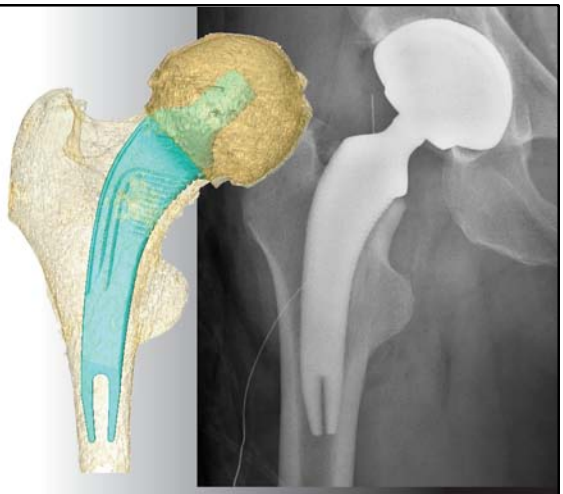

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Thigh Pain Occurrence Rate in a Short, Tapered, Porous, Proximally-Coated Cementless Femoral Stem - Clinical and Radiological Results at 2-Year Follow-Up

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Abstract

Introduction: Short stems have been designed with the purpose of preserving bone tissue, decreasing the incidence of thigh pain and facilitating surgical techniques. The aim of our study was to assess whether a shortened tapered conventional stem was able to reduce the incidence of thigh pain.

Methods: Between March 2010 and December 2012, 200 patients were enrolled in the study. Visual analogue scale (VAS) that included mapping of the pain, Harris Hip Score (HHS), Short Form-12 (SF-12) and radiographic outcomes were evaluated prior to surgery as well as at 6, 12 and 24 months post-operatively.

Results: After 6 months, 6 patients (3%) had thigh pain. After 12 months, 3 patients (1.5%) complained about thigh pain. After 2 years, 2 patients (1%) had thigh pain. There was no correlation between pain and clinical, radiological, or demographic variables.

Conclusion: The shortened tapered conventional stem resulted in a lower incidence of thigh pain for up to 2-years following surgery, compared with conventional or other short stems.

Keywords: *hip osteoarthritis; osseointegration ; radiographic evaluation; short stem prosthesis; thigh pain; total hip arthroplasty*
Level of Evidence: *AAOS Therapeutic Level III*

Introduction

There has been increasing interest for minimally invasive total hip replacement (THR) [1,2] and most of the attention has been focused on reducing surgical exposure [3].

The main reason is related to expectations after joint replacements particularly with regard to restoring quality of life, involving high-activity recreational interests. Consequently patients may face revision procedures within their lifetime [4,5] therefore also preserving bone stock is par-

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ticularly important [6].

The incidence of thigh pain after cementless hip prosthesis has been reported in the literature as being present in 1.9% to 40.4% of cases [7], while the occurrence of thigh pain in patients with the original Tri-Lock design varies from 2% to 9% [8,9].

Short stems have been designed with the theoretical advantages of preserving bone tissue, decreasing stress shielding, reducing the incidence of thigh pain post-operatively, facilitating minimally invasive surgical techniques, increasing long-term survival of the stem, and enabling surgical revision procedures.

The Tri-Lock stem has been available since 2009 in the USA and since 2010 in Europe in its short-stemmed (Trilock BPS) variant [9-11].

The primary aim of our study was to assess whether the new stem was able to reduce the incidence of thigh pain reported to vary from 2% to 9% with the original design [8,9]. Additionally, the study was also designed to assess if pain, when present, was positively associated with different clinical, radiological and demographic variables.

Methods

Between March 2010 and December 2012, 200 consecutive patients were enrolled in the study. All implantations were performed by a single surgeon. All patients underwent Total Hip Arthroplasty (THA) using the cementless femoral Tri-lock BPS (DePuySynthes, Warsaw, IN), a Pinnacle acetabular cup (DePuySynthes), a polyethylene insert (Marathon 10° hooded insert, DePuySynthes) and a ceramic head Biolox Delta 32 mm ball head (Ceramtec, Plochingen, Germany).

Table 1. Demographics of Patients

Sex	
- Females	120 (60%)
- Males	80 (40%)
Age* (years)	68.7 (37.5-85)
BMI* (kg/m2)	26.7(16.4-38.1)
Femoral canal (Dorr type)	
- Type A	49 (24.9%)
- Type B	139 (69.5%)
- Type C	12 (6%)
Offset	
- Standard	29 (14.6%)
- High	171 (85.4%)

**Presented as mean (range)*

All patients underwent total hip replacement performed via postero-lateral approach.

Patients were assessed both clinically and radiographically prior to surgery and at 6, 12 and 24 months post-operatively. Postoperative evaluation included the assessment of pain using the VAS, which included mapping of the pain.

On the Visual Analogue Scale pain ranging from 1 to 3 cm was classified as mild, from 3 to 7 cm as moderate, and from 7 to 10 cm as severe. For assessing thigh pain, the definition of Barrack was used, i.e. only in the anterior portion of the thigh and distally to the inguinal area [12].

Patients were also evaluated preoperatively and at each follow-up by means of Harris Hip Score (HHS) [13] and the self-administered Short Form-12 (SF-12) [14].

Radiographic assessment was conducted according to a standard radiographic protocol. The antero-posterior view of the pelvis was taken in weight-bearing conditions and with the legs internally rotated by 15°. Radiographic analysis was conducted with the aid of IMPAX (Server application: CZPACS; IMPAX Version 6.4.0.3125 2011; AGFA Healthcare N.V., Septestraat 27, B-2640 Morstsel, Belgium).

Radiographic assessment included classification of the morphology of the femoral canal according to Dorr [15], frontal alignment of the prosthetic implant (Figure 1), along with subsidence of the stem over time [16], osteolysis, radiolucent lines (RLL), and heterotopic ossification according to Brooker [17]. The presence of cortical hypertrophy was also assessed.

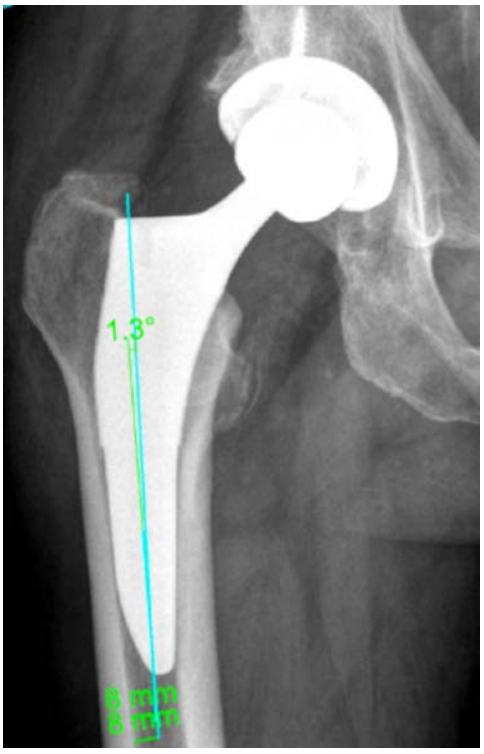

Figure 1. X-ray based determination of varus-valgus angles. The individual varus-valgus angle is calculated by 90° minus the depicted angle.

We considered a threshold value of 5° for varus/valgus malposition and a progressive subsidence of more than 3 mm as a negative indicator of future stability of the implant [18-21].

Ethics Committee approval was obtained for collection and retrospective analysis of the data regarding this cohort of patients. Informed consent was obtained from all individual participants included in the study.

For continuous data, Shapiro-Wilk tests were used to test for major violations of the normality assumption. As normal distribution could not be assumed for clinical outcome data, data are presented as median and interquartile range (IQR). Normally distributed continuous data are presented as means±standard deviation (SD). Categorical variables are presented as frequencies and percentages. Statistical analyses were performed using Stata/SE 12.1 (Stata Corp, College Station, TX, USA)

Results

The mean age of the study population at the time of index surgery was 68.7 ± 9.8 years (range, 37.5 – 85.1 years). There were 120 females (60%) and 80 males (40%). The mean BMI was 26.7 ± 3.7 kg/m2 (range, 16.4 – 38.1 kg/m2). 49 patients (24.5%) were classified as Dorr A, 139 patients (69.5%) as Dorr B, and 12 patients (6%) as Dorr C. 171 patients (85.4%) received a high offset stem, whereas 29 patients (14.6%) received a standard offset stem (Table I). Total HHS of the patients increased from a median of 44 (IQR, 35 - 52), preoperatively, to 98 (IQR, 96 - 100) after 6 months, 100 (97 - 100) after 12 months and 100 (98 – 100) after 24 months. The median Harris Hip Pain score was 10 (IQR, 0-20) at the preoperative assessment, and 44 (44 – 44) at each subsequent follow-up (Figure 2).

At 12 months, one patient failed to present at follow-up; at 24 months, two additional patients withdrew their consent for further participation in the study.

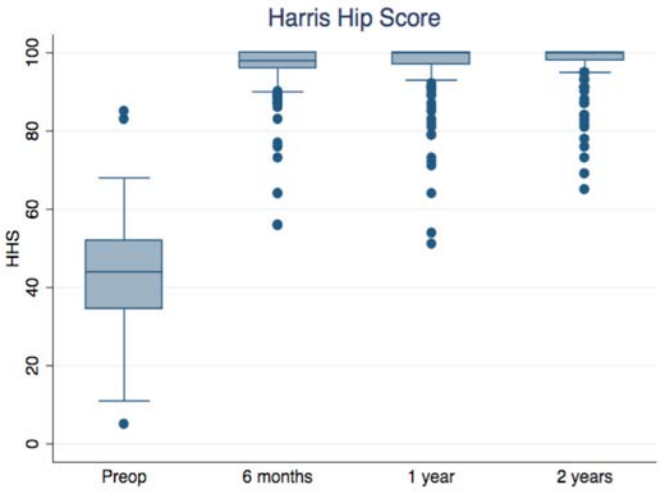

Figure 2. Harris Hip Score at each visit

At 6 month follow-up, 11 out of 200 patients (5.5%) complained of pain, 6 patients (3%) had thigh pain and 5 patients (2.5%) had trochanteric pain. After 12 months, 6 out of 199 patients (3%) experienced pain, 3 patients (1.5%) had thigh pain, and 3 patients (1.5%) had trochanteric pain. After 2 years, 5 out of 197 patients (2.5%) experienced pain, 2 patients (1%) with thigh pain and 3 patients (1.5%) with trochanteric pain. At 6 months, 2 patients experienced moderate pain, and at 12 and 24 months, 1 patient experienced moderate pain (Figure 3).

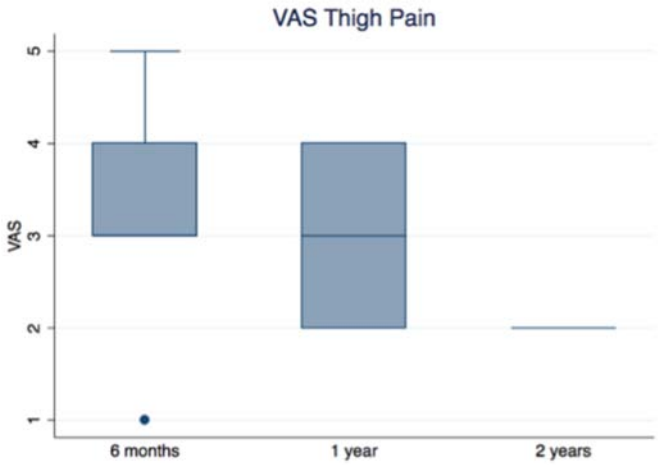

Figure 3. VAS score for thigh pain

Trochanteric pain was mild in 3 patients and moderate in 2 patients at 6 months. At both 12 as 24 months, trochanteric pain was mild in 1 case and moderate in 2 cases. We had no occurrence of inguinal pain in this cohort of patients.

The mean preoperative SF-12 Physical Health Composite Scale scores (PCS) was 27.4 ± 3.5; at 6, 12 and 24 months of follow-up, 53.5 ± 4.5, 53.9 ± 4.7, and 54.1 ±5.2, respectively. The mean preoperative SF-12 Mental Health Composite Scale scores (MCS) was 56.4 ± 5.7; at 6, 12 and 24 months of follow-up 59.7 ± 2.7, 59.6 ±3.4, and 59.6 ± 3.4, respectively. At the final radiological follow-up, subsidence of 3 mm or more was observed in 8 patients, with a mean (SD) subsidence value of 3.4 (SD, 0.5, range, 0-4) mm. In 87 patients, the stem was positioned at the slight varus (mean angle 1.5°) in 106 patients in slight valgus, (mean angle of 2.5°). In 4 patients in neutral alignment.

Implant positioning in the frontal plane could not be determined in 3 patients. No RLLs or osteolytic lesions were seen. Pedestal formation was observed in 18 out of 197 patients at the 2 year follow-up (9.1%). Concomitant pedestal formation did not occur in any of the patients with subsidence of at least 3 mm. In 1 patient (0.5%), at the 2-year follow-up, detachment of the greater trochanter oc-

curred. In a second patient (0.5%), partial avulsion of the apex of the greater trochanter took place. In both cases, treatment was conservative and successful. Two patients presented grade III heterotopic bone formation, but neither of these cases reported thigh or trochanteric pain.

In total, we observed 10 cases of cortical hypertrophy (5%), 3 cases at 12 months and 7 cases at 24 months. No correlation with pain was observed. We had no cases of periprosthetic fracture to report.

No patients underwent revision surgery during the 2 years of observation.

Discussion

The incidence of pain in the thigh with the original Tri-Lock design was reported as being between 2-9% [22] and 9.5% at 1 year and 8.7% at 2 years [23]. In 2008, the Tri-Lock femoral stem was modified so as to preserve the proximal femoral bone stock.

The aim of the study was to assess if the modified Tri-Lock BPS stem was able to reduce the incidence of thigh pain.

The literature evidence on these type of stems is limited. In the work of Khanuja et al. for Type-4 stem designs, which we refer to for Tri-Lock BPS, there are four reports altogether, involving 563 hips [8] reporting favourable clinical outcome results.

In a paper recently published [24], investigators reported favorable clinical and radiological results with Tri-Lock BPS at 5 years in a cohort of 119 out of 124 originally enrolled patients with a low (1.6%) incidence of thigh pain.

In our experience at 6 months, 2 patients (1%) experienced moderate pain, and at 12 and 24 months 1 of these 2 patients (0.5%) still reported moderate pain. Trochanteric pain was reported in 9 different patients (4.5%). At 12 and 24 months, trochanteric pain was mild in 1 case (0.5%) and moderate in 2 cases (1%).

In agreement with observations from other authors that in these Type-4 stems an extremely low incidence of periprosthetic fractures was reported (mean, 0.2%; range, 0% to 0.6%) [8], we also had no cases of periprosthetic fracture to report.

The total HHS, increased from a median preoperative value of 44 to 100 at 24 months.

The SF-12 in its two components mental (MCS) and physical (PCS) showed the following pattern: we reported a mean preoperative SF-12 MCS of 56.4 ± 5.7; and at 6, 12 and 24 months the SF-12 MCS were 59.7 ± 2.7, 59.6 ±3.4, and 59.6 ± 3.4, respectively.

Conversely, the PCS, which is centered on concrete activities shows a more dynamic and positive pattern between pre- and post-operative values, with mean preoperative SF-12 PCS of 27.4 ± 3.5; at 6, 12 and 24 months the SF-12 PCS values increased to 53.5 ± 4.5, 53.9 ± 4.7, and 54.1 ±5.2, respectively.

Strengths of this study are its completeness of pre-operative data and the low postoperative dropout rate, along with the meticulous reporting of thigh pain. Study limitations include the lack of a control group as well as the short follow-up period of the study. Due to the low incidence of postoperative pain, we were unable to highlight any factors that might be associated with postoperative pain.

Conclusion

Tri-lock BPS DePuy proved to be an easy-to-use device. Results obtained up to 2 years of follow-up show excellent radiographic osseointegration, no cases of septic loosening, and no images of progressive RLL or periprosthetic osteolysis. Furthermore, compared to the literature, there was a low percentage of thigh pain at 6, 12 and 24 months of follow-up.

These are the first clinical and radiological results on a relevant cohort of patients with Tri-lock BPS, which in this primary phase (2-year follow-up), concentrated primarily on incidence and prevalence of thigh pain. This observation deserves longer-term follow-up on clinical outcome, radiological appearance and implant survival.

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Disclosure

The authors declare that there is no conflict of interest regarding the publication of this paper. For full disclosures refer to last page of this journal.

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Medial Tibial Reduction Osteotomy is Associated with Excellent Outcomes and Improved Coronal Alignment

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Abstract

Background: The medial tibial reduction osteotomy (MTRO) was introduced to achieve coronal ligamentous balance in total knee arthroplasty (TKA) patients with substantial preoperative varus deformity. Limited data exists on the outcomes of patients requiring an MTRO. This study compares outcomes of a matched cohort of patients that either required or did not require an MTRO during TKA.

Methods: A retrospective review was performed on 67 patients that underwent an MTRO during primary TKA to achieve coronal balance. This patient population was matched 1:1 to another cohort of TKA patients by age, gender, and BMI that did not require an MTRO. A clinical and radiographic evaluation was utilized to compare the two cohorts.

Results: Preoperatively, the tibiofemoral angle was 3.42° valgus versus 6.12° varus in the control and MTRO cohorts respectively (p=0.01). Mean postoperative tibiofemoral angles were 3.40° versus 2.43° valgus respectively. Postoperative Knee Society Scores were superior in the MTRO cohort (183.84 versus 174.58; p=0.04). Intraoperatively, no superficial MCL releases were required to achieve coronal balance in either cohort. Complications were similar and limited in both groups. Medial tibial bone resorption was observed in 64% of MTRO subjects averaging 2.02mm versus only 0.3mm in the control cohort (p=0.01).

Conclusion: Patients requiring an MTRO achieved similar alignment and superior knee scores compared to a control cohort with less varus deformity. This procedure eliminated the need for release of the superficial MCL. Resorption of medial tibial bone was commonly observed, possibly secondary to saw-induced thermal necrosis associated with performing an MTRO.

Keywords: *varus deformity; medial release; total knee replacement; alignment; stability*
Level of Evidence: *AAOS Therapeutic Level II*

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Introduction

A fixed varus deformity is commonly seen in patients undergoing primary total knee arthroplasty (TKA). The severity of the deformity may lead to longer surgical times, increased difficulty in soft tissue balancing, and trouble achieving optimal bony alignment [1–4]. There are numerous methods of achieving soft tissue balance in the varus knee including a variety of ligament releases, [5,6] and more recently a medial tibial reduction osteotomy [7–9] (MTRO) has been described. This technique consists of lateralizing the tibial tray with resection of the uncapped medial tibial bone. In some cases, this is associated with downsizing of the tibial tray. The utilization of the MTRO may result in a decrease in operative times when compared to soft tissue releases alone [10] and typically lessens the amount of medial soft tissue releasing required to correct the varus deformity. Additionally, aggressive medial soft tissue release can lead to attenuation of the medial collateral ligament [11] (MCL). The following study describes a treatment algorithm for balancing a fixed varus knee deformity by incorporating a series of medial soft tissue releases and a MTRO to achieve coronal mechanical alignment. Secondary outcomes for this study include: 1) to report what patient or radiographic factors are associated with a need to perform a MTRO, 2) to review the radiographic and clinical outcomes of patients that underwent an MTRO, and 3) to compare the results of patients that required an MTRO to a matched cohort of TKA patients with a varus deformity that did not require a MTRO.

Materials and Methods

This analysis was initiated after Institutional Review Board approval. A retrospective review of prospectively collected data of patients undergoing primary TKA with varus deformities from 2009 to 2011 at our institution was performed. All patients underwent a primary TKA implanted by the senior author (DAD). All subjects were implanted with a cemented posterior cruciate substituting TKA (PFC Sigma, DePuy, Warsaw, IN). Sixty-seven patients were identified that required an MTRO to achieve coronal balance. This patient population was then matched by age, gender, and BMI to a cohort of 67 TKA patients with preoperative varus deformities that did not require an MTRO during this time period.

Surgical Approach

Each knee was exposed utilizing a standard medial parapatellar arthrotomy. The distal femoral and proximal tibial resections were initially performed to create the extension gap. Coronal balance was assessed with a spacer block. If the medial extension gap was noted to be tighter than the lateral aspect of the extension gap, a series of steps were performed to achieve a rectangular extension gap (Table 1). A stepwise medial release was performed beginning with releasing the deep medial collateral ligament to the mid-coronal plane of the tibia and removal of femoral and tibial osteophytes which create tension on tightened medial structures. Removal of any distal femoral osteophytes located underneath the superficial medial collateral ligament at this point is particularly important (Figure 1). A spacer block is then inserted into the extension gap to assess gap balance. If medial tightness persists, release of the posteromedial capsule (posterior oblique ligament) was performed. Gap symmetry was reassessed with a spacer block after each release. Occasionally, there were large (>1cm) posterior femoral osteophytes that may tent the posteromedial capsule contributing to gap asymmetry. In these cases, a preliminary four millimeter resection of the posterior aspect of the medial femoral condyle was executed with the knee flexed at 90 degrees and a laminar spreader positioned in the lateral aspect of the flexion gap to allow access to the posterior osteophytes (Figure 2A). A curved osteotome was then used to remove the posterior femoral osteophytes (Figure 2B). This step is crucial as these osteophytes can mislead the surgeon into thinking a supporting soft tissue structure is too tight, resulting in a surgical release of that "tight" structure. If the osteophytes are removed late, after soft tissue releases have been performed, unwanted laxity of the released structures is incurred that results in asymmetry of the flexion and extension gaps leading to potential malrotation of the femoral component if a gap balancing surgical technique is utilized.

Table 1. Authors' Sequence Of Steps Utilized To Correct A Varus Deformity And Obtain A Rectangular Extension Gap

1. Release of the deep medial collateral ligament to the mid-coronal plane of the tibia
2. Removal of all femoral and tibial osteophytes
3. Release of the posteromedial capsule (posterior oblique ligament)
4. Perform a medial tibial reduction osteotomy
5. Release of the semimembranosus tendon
6. Perforation of the superficial medial collateral ligament with an 18 gauge needle
7. Release of the distal attachment of the superficial medial collateral ligament

If an asymmetric extension gap remains after these sequential techniques, a MTRO was utilized. Initially, the tibial base plate trial was lateralized as much as possible

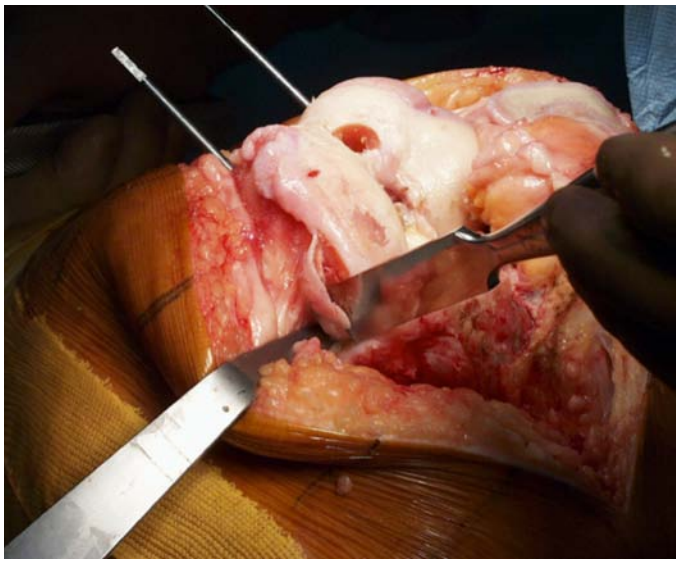

Figure 1. Removal of any distal femoral osteophytes located underneath the superficial medial collateral ligament.

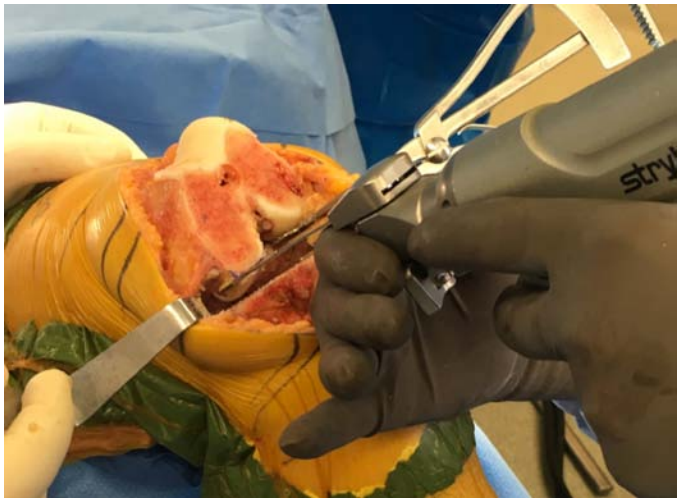

Figure 2A. Four millimeter resection of the posterior aspect of the medial femoral condyle.

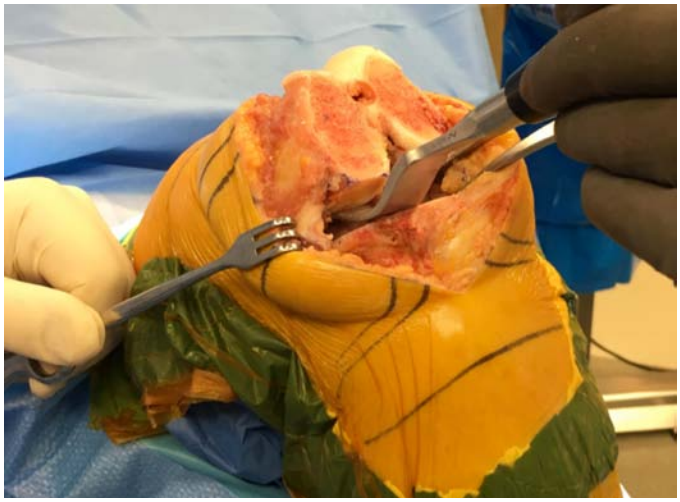

Figure 2B. A curved osteotome was then used to remove the posterior femoral osteophytes.

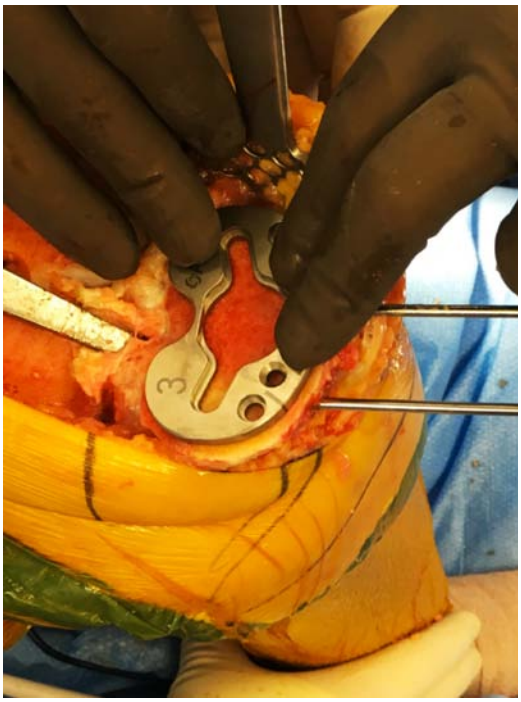

Figure 3A. Initially, the tibial base plate trial was lateralized as much as possible without overhanging the perimeter of the lateral tibial plateau.

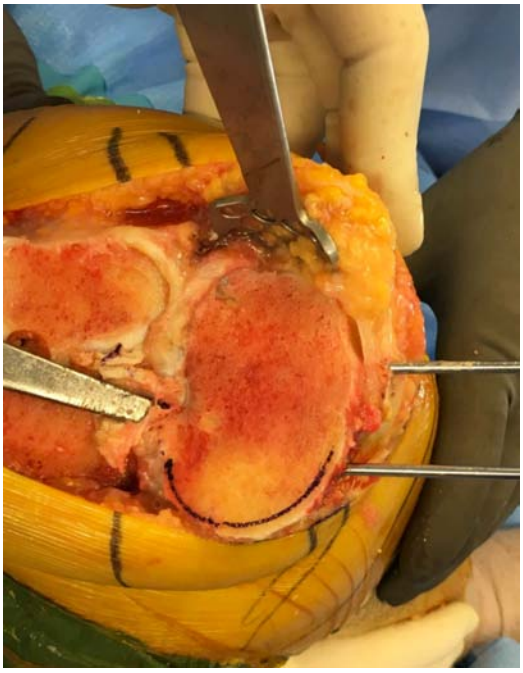

Figure 3B. A marking pen was used to outline the medial extent of the tibial tray on the medial tibial plateau.

without overhanging the perimeter of the lateral tibial plateau (Figure 3A). A marking pen was used to outline the medial extent of the tibial tray on the medial tibial plateau (Figure 3B). The bone that was exposed medial to the outline of the tibial tray was then removed utilizing a combination of an oscillating saw and a rongeur (Figures 4A and 4B). This reduces tension on the medial collateral ligament, facilitating correction of the varus deformity. Lastly, if asymmetry persists after a substantial MTRO was performed (>2 mm difference in gaps), consideration for release of the superficial MCL was considered.

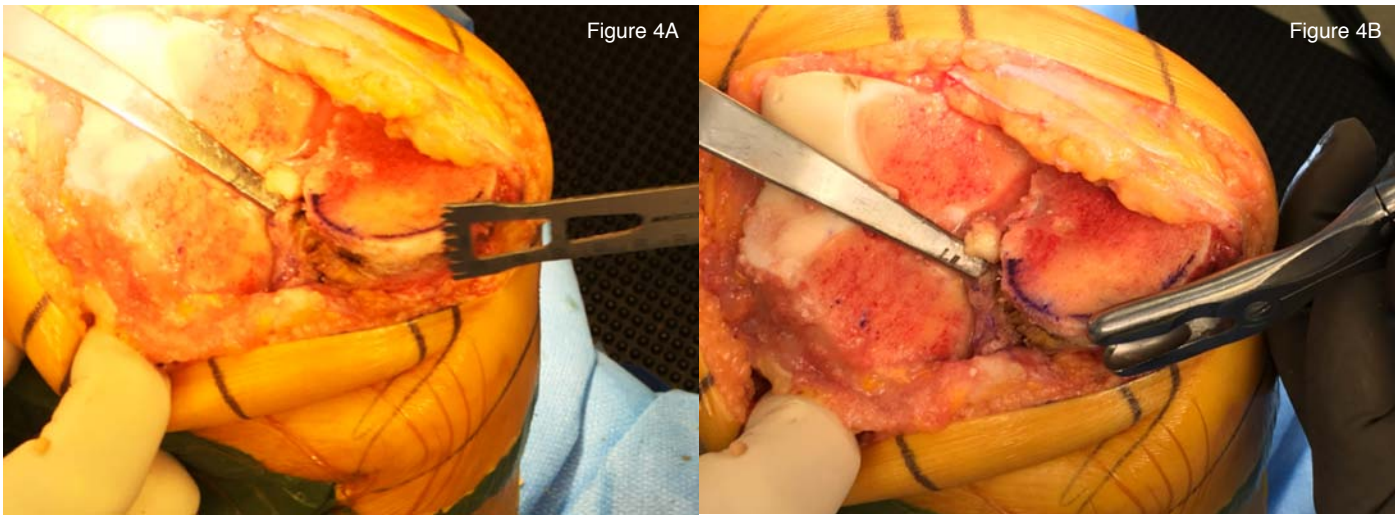

Figure 4A & 4B. The bone that was exposed medial to the outline of the tibial tray was then removed utilizing a combination of an oscillating saw and a rongeur.

Post-operative protocol

All patients followed a standardized postoperative rehabilitation protocol, allowing full-weight bearing on the operative extremity immediately after the operative procedure. Patients ambulated with the use of two crutches or a walker for 2 weeks with gradual progression to ambulation without an assistive device over the next 2-4 weeks. Outpatient physical therapy three times weekly for six weeks was utilized for all patients. Postoperative clinic evaluations were performed at 2 weeks, 6 weeks, 3 months, and at 1, 2 and 5- years. A functional analysis, physical examination, and radiographic assessment were performed at each follow-up appointment.

Radiographic Analysis

Preoperative and postoperative radiographs including a standing AP view of both knees, lateral and merchant patellar views, as well as a long leg radiograph were obtained on all subjects. The following data points were analyzed on preoperative films: femoral and tibial articular surface angles and tibiofemoral angle (Figure 5). Six-week full-length radiographs were reviewed to determine the alignment of the tibial and femoral components, the femoral-tibial angle and to assess the status of the medial tibial bone early following MTRO. Final follow-up radiographs were reviewed to determine component position and fixation, overall alignment, and the presence of any medial tibial bone resorption.

Patient Outcomes

Knee Society scores were recorded at the preoperative and all subsequent postoperative clinical visits. Additionally, all revisions, complications and or reoperations were continually recorded after TKA implantation.

Patient Demographic Data

We identified 67 patients that underwent an MTRO at the time of TKA. This patient population was then matched to a control cohort of 67 patients with preoperative varus deformity that did not require an MTRO at the time of primary TKA by age, gender, and BMI (Table 2).

The implant data for both cohorts can be seen below in Table 3. Mobile bearings were typically utilized in younger patients and fixed bearing in more senior patients (> 65-70 years).

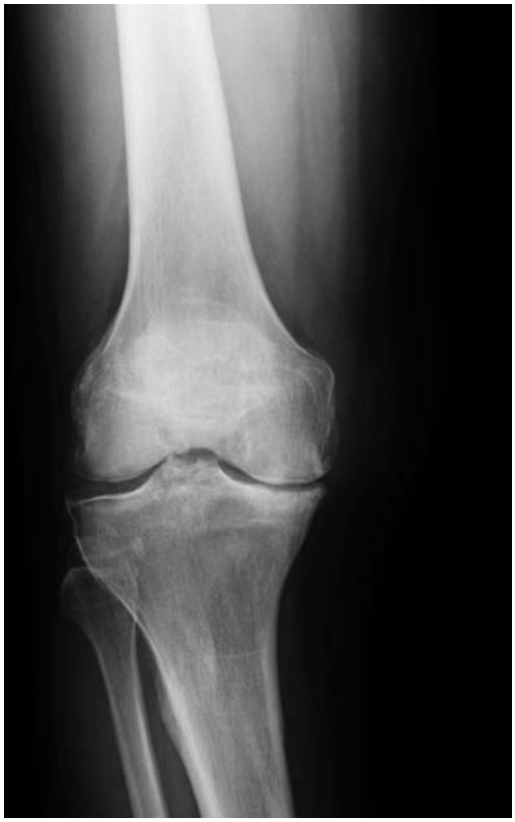

Figure 5. Femoral and tibial articular surface angles and tibiofemoral angle.

Table 2. Patient Demographics

	MTRO Cohort	Control Cohort	P-value
Gender	(13F, 54M)	(19F, 48M)	
Age (years)	65.81 (±7.73)	64.90 (±7.87)	0.50
BMI (kg/m2)	29.49 (±4.74)	29.70 (±5.30)	0.81
Follow-up (years)	4.62 (±1.14)	4.60 (±1.32)	0.91

Table 3. Implant Data

Implant Type	MTRO Cohort	Control Cohort
PFC Sigma Rotating Platform	48	39
PFC Sigma Fixed Bearing	7	9
PFC Sigma All Polyethylene Tibia	12	18
PFC Sigma TC3 Rotating Platform	0	1

Table 4. Preoperative Radiographic Parameters

	MTRO Cohort	Control Cohort	P-value
Overall	86.12 (±4.17)	93.42 (±7.08)	0.01
Femoral	96.27 (±2.14)	96.99 (±2.34)	0.07
Tibial	85.79 (±2.83)	87.54 (±2.04)	0.01

Table 5. Postoperative Radiographic Evaluation

	MTRO Cohort	Control Cohort	P-value
Tibiofemoral angle	92.43 (±1.55)	93.40 (±1.62)	0.001
Femoral Angle	93.69 (±1.41)	94.33 (±1.72)	0.02
Tibial Articulation Surface Angle	89.55 (±1.10)	89.00 (±0.95)	0.002
Amount of Correction	6.31 (±4.37)	-0.02 (±6.75)	0.01
Number of Patients with Medial Tibial Bone Resorption	43/67	2/67	N/A
Medial Tibial Bone Resorption (mm)	2.02 (±2.18)	0.03 (±1.03)	0.01

Statistical Analysis

Preoperative radiographic image dependent variables analyzed included femoral-tibial angle, femoral component angle, and tibial component angle. Immediate postoperative dependent variables evaluated included the amount of correction (difference between preoperative and postoperative femoral-tibial alignment), overall femoral-tibial angle, femoral component angle, tibial component angle, and the presence of medial tibial bone-cement radiolucent lines. Knee Society scores were considered as dependent variables at preoperative and final follow-up evaluations. Dependent variables were compared across groups using Student's t-test (for equal variances) and Welch's analysis of variance test (for unequal variances). Equality of variance was assessed using Levene's test. A multiple linear regression analysis was used to assess the risk between preoperative radiographs and patient demographics to requiring a MTRO. Pearson product moment correlation was used to assess the correlation between preoperative radiographic results to medial tibial bone resorption at final follow-up evaluation. The level of significance for all inferential statistics was set at (alpha = 0.05). All inferential statistics were performed using SPSS v22.0 (IBM Inc.).

Results

Patient factors associated with increased MTRO

Utilizing the patient's preoperative radiographs to analyze preoperative tibiofemoral alignment, a higher degree of varus deformity was observed in the MTRO cohort than the control cohort, (3.88 degrees varus vs. 3.42 degrees valgus respectively, p=0.01) (Table 4). The tibial articular surface angle was aligned in a greater varus posture in the MTRO cohort (85.79 vs. 87.54 degrees, p=0.01). There was no statistically significant difference in the femoral articular surface angle between the two groups (96.27 vs. 96.99 degrees, p=0.07). No patient in either group required a superficial MCL release to obtain coronal alignment.

Radiographic Outcomes

The postoperative alignment at final follow-up of the MTRO cohort was statistically significantly different for overall tibiofemoral angle, femoral articular surface angle, and tibial articular surface angle, respectively (Table 5). There was significantly more correction in the MTRO cohort. Medial tibial bone resorption was significantly greater in the MTRO cohort. In the MTRO cohort, 64% of subjects were noted to have medial tibial bone resorption versus only 3% in the control cohort (p=0.008). Additionally, within the MTRO cohort, 77% had bone resorption with a cobalt chromium tibial tray vs 8% with an all polyethylene tibial tray (p<0.01). In the control cohort, 4% of patients with a cobalt chromium tray had resorption vs. 0% in the all polyethylene cohort.

Clinical Outcomes

The preoperative clinical evaluation identified no statistically significant difference in pain scores, extension, flexion, total function, or Knee Society Scores. However, there was a statistically significantly increase in valgus alignment (p=0.01) and total knee score (p=0.004) in the control cohort. Postoperatively, there were no statistically significant differences in pain score, extension, flexion, alignment or total Knee Society Scores. There was a statistically

Table 6: Pre- and Postoperative Clinical Evaluations

	MTRO Cohort	Control Cohort	P-value
Preoperative			
Pain Score	12.38 (±10.35)	11.36 (±6.84)	0.53
Extension	7.52 (±5.57)	6.67 (±6.23)	0.44
Flexion	119.44 (±8.89)	118.96 (±9.95)	0.78
Valgus Alignment	16.71 (±7.25)	10.26 (±9.11)	0.01
Total Function	58.57 (±15.49)	60.00 (±16.50)	0.63
Total Knee	36.30 (±14.89)	43.87 (±13.16)	0.004
Total Score	94.87 (±26.02)	103.87 (±23.51)	0.05
Final Follow-up			
Pain Score	45.00 (±9.84)	44.27 (±10.11)	0.69
Extension	0.79 (±1.73)	1.84 (±4.69)	0.12
Flexion	124.94 (±16.50)	121.93 (±14.79)	0.30
Valgus Alignment	0.32 (±2.52)	0.17 (±0.91)	0.68
Total Function	90.00 (±14.59)	82.27 (±23.07)	0.04
Total Knee	93.84 (±10.62)	92.31 (±11.12)	0.45
Total Score	183.84 (±20.83)	174.58 (±28.18)	0.04

Table 7: Complications

	MTRO Cohort	Control Cohort
Manipulation	2	1
DVT/PE	1	1
Blood transfusion	0	1
Total	3	3

significant increase in the total function (p=0.04) and total knee score in the MTRO cohort (p=0.04; Table 6).

Complications/Revisions

The overall complication rate was similar and limited in both cohorts (4%). The most common complication was a closed manipulation for arthrofibrosis (Table 7).

We identified one revision surgery in a 66 year old female, with a preoperative BMI of 39.0 and no other significant medical comorbidities, six years postoperatively. The patient was noted to have increasing medial tibial resorption and then collapse as well as aseptic tibial loosening. This patient was revised to a stemmed tibial component two years postoperatively with no additional loosening at final follow-up.

Discussion

Numerous studies have evaluated methods for obtaining precise coronal alignment in the varus knee [1,5]. Recently, the MTRO has been described as an alternative or additive procedure to improve the correction achieved in arthritic knees with severe fixed varus deformities [7,8]. Dixon et. al. performed an MTRO on 10 patients with substantial varus deformity (mean 24 degrees). They noted improvements in Knee Society and function scores (24 and 34 to 94 and 85) with no patient requiring revision surgery. The average follow-up tibiofemoral angle was 4 degrees. More recently, Mullaji and Shetty evaluated 71 primary TKAs in patients that required an MTRO [12]. They specifically wanted to determine the amount of deformity correction achieved with an MTRO and correlate the amount of tibia osteotomized with the amount of correction achieved. For every 2mm of tibial bone resected, they achieved one degree of deformity correction.

We performed a retrospective review of patients with varus deformities requiring a TKA to determine the patient and radiographic factors that are associated with a need to perform a MTRO, to review the radiographic and clinical outcomes of patients that underwent an MTRO, and lastly to compare the results of patients that required an MTRO to a matched cohort of TKA patients with a varus deformity that did not require a MTRO. At our institution, the senior author proceeds with a systematic approach for achieving coronal alignment. The MTRO is utilized for severe fixed varus deformities that are uncorrectable with sequential medial soft tissue releases.

We noted several limitations to our study. First, this was a retrospective review and therefore suffers all of the limitations of this type of study. Secondly, we have relatively short-term follow-up duration. However, we did not believe longer follow-up was necessary to show the ability of the MTRO to safely and accurately achieve coronal alignment. Thirdly, the radiographic measurements obtained from this study were measured utilizing standing AP knee radiographs (14" X 17" films) as opposed to full-length standing films. The AP knee radiographs have been shown to have no statistically significant difference in measuring alignment in patients compared with full-length standing-films in previous studies [13]. Additionally, we only routinely obtain full length standing films at the six week postoperative evaluation. Therefore, we elected to review the AP knee radiographs at all time periods to standardize the measurements throughout the duration of the study. Next, we did not compare similar cohorts with regards to preoperative varus deformity. However, we note that preoperative deformity is associated with requiring an MTRO and therefore we were unable to match the cohort by this variable. Finally, we performed a matched cohort for age, gender, and BMI to control for patient demographic data that may affect outcomes. However, there may be several other patient comorbidities that could impact outcomes that

were not controlled.

Utilizing a systematic approach for obtaining coronal balance in the varus knee potentially avoids the need to release the superficial MCL. Preoperatively, there was a statistically significant increase in varus tibiofemoral angles in the MTRO cohort. Although there was a statistical difference in alignment between the two groups, there was no clinically significant difference in the final postoperative tibiofemoral alignment. We were able to obtain alignment within approximately one degree of the control cohort. Additionally, no patient in the MTRO group required implantation of a constrained implant or required a superficial MCL release. We believe that the MTRO offers a safe and reliable modality for achieving a well-balanced TKA, while avoiding the potential risks of injury to the superficial MCL that can occur with both traditional and piecrusting techniques of release [14].

The pre-operative tibiofemoral and tibial articular surface angles were noted to be statistically in more varus alignment in the MTRO cohort. The majority of the varus deformity seen in varus gonarthrosis was derived from the tibia, with minimal contribution from the femoral anatomy. The femoral articular surface angle was not significantly different between the cohorts. Additionally, we did not identify any patient-specific risk factors including weight, age, or gender. The pre-operative tibiofemoral deformity identified on pre-operative radiographs is likely the best predictor for patients that will require an MTRO.

Both cohorts exhibited excellent clinical results with mean Knee Society total knee scores of 183.84 and 174.58 for the MTRO and the control cohorts, respectively. The combined and function Knee Society scores were statistically better in the MTRO group but likely do not represent substantial clinical differences. Additionally, both groups demonstrated similar range of motion and pain scores. The revision rates and complication rates were low and similar between these groups showing the MTRO can be performed without increased risk at short- to mid-term follow-up evaluation.

An interesting post-operative radiographic finding was the presence of medial tibial bone resorption underneath the medial periphery of the tibial baseplate, observed in 64% of the MTRO patients (Figures 6A and 6B). Only two patients in the control cohort were noted to have medial tibial bone resorption (p =0.008). Initially, we speculated that the presence of medial tibial bone resorption was due to thermal necrosis from the saw blade used to trim the sclerotic medial tibia during an MTRO. However, it also could be related to stress shielding as we noted a statistically significant increase in medial tibial bone resorption in patients with a metal backed rotating platform tibial tray

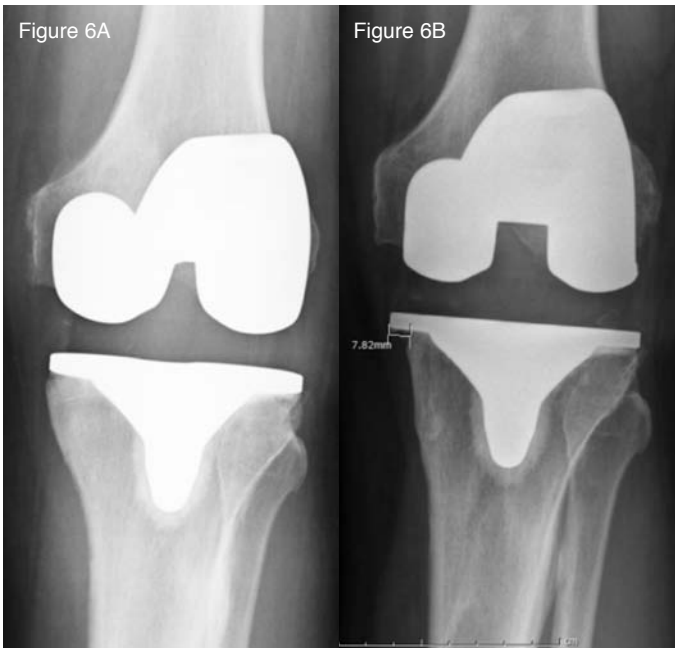

Figure 6A & B: Radiographic finding of the presence of medial tibial bone resorption underneath the medial periphery of the tibial baseplate.

compared to an all polyethylene tibial component (37/48 (77%) vs 1/12 (8%), p<0.01). This has led the authors to speculate that the medial tibial bone resorption may be a function of stress shielding in combination with potential thermal necrosis. The mechanism may be related to unloading the medial tibial plateau by correcting the varus alignment and further stress-shielding by utilizing a cobalt chromium tibial base plate. Additionally, the two patients that had medial tibial bone resorption in the control cohort were implanted with a cobalt chromium tray. Further investigation is required to determine the exact etiology of this unique phenomenon. At mid-term follow-up duration, this does not appear to be clinically significant, however, close monitoring of these patients will continue at our institution. In light of this observation, the authors now perform the MTRO with a rongeur or add irrigation if the sclerotic medial tibial is being removed using a saw to lessen the potential for thermal necrosis.

Conclusion

A MTRO was found to be a safe and effective method of achieving coronal balance and alignment in patients with fixed varus knee deformity requiring a TKA. No patient in the MTRO group required a release of the superficial MCL or required increased implant constraint. The MTRO was associated with statistically significantly improved Knee Society scores and similar final range of motion. Additionally, there was no substantial difference in revision

or complication rates between the MTRO and control cohorts. Medial tibial bone resorption was present in over half of the patients in which a MTRO was performed. The exact mechanism of this phenomenon is unknown at this time but may be related to either stress shielding or thermal necrosis associated with the osteotomy. Longer follow-up is necessary to determine if this finding will result in any adverse clinical outcomes. However, at this time, the medial tibial bone resorption did not impact implant survivorship or patient outcomes and requires continued surveillance. We currently recommend the use of an MTRO to achieve coronal balance in patients with substantial varus deformity.

Disclosure

The authors declare that there is no conflict of interest regarding the publication of this paper. For full disclosures refer to last page of this journal.

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Total Hip Arthroplasty Loosening Due to Mycobacterium Tuberculosis: A Case Report and Review of the Literature

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Abstract

Context: Prosthetic joint infection due to Mycobacterium tuberculosis (MTB) with no previous history of pulmonary or extra pulmonary tuberculosis is a rare complication.

Aims: To report the case of a patient with tuberculous mycobacterial prosthetic hip infection, 14 years after surgery for post traumatic osteoarthritis, with no previous history of tuberculosis.

Methods: A 46-year-old male presented with acetabular loosening of a cemented total hip arthroplasty with normal biologic parameters. A one stage revision surgery was planned. Intraoperative findings suggested mycobacterial tuberculous infection with presence of periacetabular yellowish rice-shaped granules.

Results: A one-stage prosthesis exchange was performed; Culture on Löwenstein-Jensen medium grew MTB days after inoculation and histological examination confirmed tuberculous infection. Patient was treated with antituberculous agents for 12 months with optimal clinical and biological response and no prosthetic loosening signs at two year follow up.

Conclusions: Total hip arthroplasty loosening due to mycobacterium tuberculosis is a rare entity, which should be considered even when no inflammatory signs are shown. Discovery of yellowish rice-shaped granules is suggestive of periprosthetic tuberculosis. Management of prosthetic joint infection due to M.tuberculosis must involve both medical and surgical therapy.

Keywords*: total hip replacement; prosthesis loosening; mycobacterium tuberculosis*
Level of Evidence*: AAOS Therapeutic Level IV*

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Introduction

Extrapulmonary tuberculosis is observed in about 20% of the total cases [1,2]. Among extrapulmonary cases approximately 10% are bone and joint infections, with peripheral arthritis being responsible for 30% of osteoarticular tuberculosis [1-4]. Usually a single joint is involved, with the hip joint being the most common [4].

Primary tubercular osteo-arthritis is well known, while periprosthetic tubercular infections are uncommon.

Prosthetic joint infection (PJI) due to MTB with no previous history of pulmonary or extra pulmonary tuberculosis is an extremely rare complication. There are only 39 cases reported in the literature.

We report the case of a patient with MTB PJI complicating a hip arthroplasty, 14 years after surgery for posttraumatic osteoarthritis, with no previous history of tuberculosis.

Case Report

A 46-year-old male was admitted to our institution for acetabular loosening of a cemented total hip arthroplasty (THA) (figure1). The arthroplasty was performed 14 years previously following a diagnosis of left hip osteoarthritis after nonoperative treatment of acetabular posterior wall fracture.

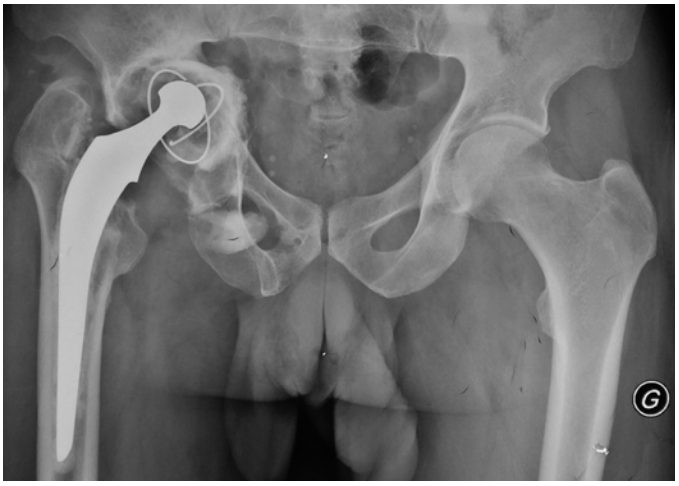

Figure 1. Initial radiographs showing acetabular loosening of left hip arthroplasty with cranial and medial migration of the cup.

On presentation the patient complained of pain and limitation of movement of the left hip. No fever or swelling around the hip was noted on admission. Chest radiograph was normal. There was no history of prior MTB infection. There was no known history of contact with MTP infection. Blood investigations demonstrated white blood cells (WBC): 7.3 K/µl, hematocrit (Hct): 33.6 %, hemoglobin (HGB): 12g/dl, erythrocyte sedimentation rate (ESR): 36 mm/hr and C-reactive protein (CRP): 0.02 mg/dl.

Pelvic radiograph showed acetabular cup loosening with implant medial and cranial migration and no evidence of stem loosening. Revision of the hip arthroplasty was planned because of suspected asceptic loosening.

Intraoperatively, yellowish rice-shaped granules were discovered around the acetabulum, which were withdrawn along with synovium fluid for culture and histopathologic examination (Figure 2).

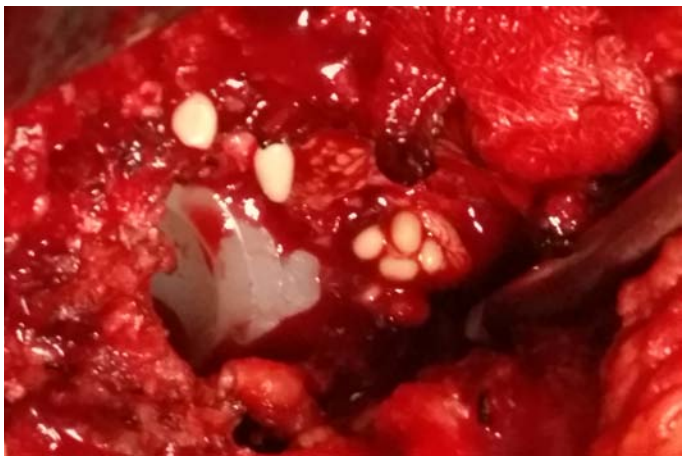

Figure 2. Peroperative finding, yellowish rice-shaped granules discovered around the acetabulum.

The prosthesis was removed, total synovectomy was done, and total hip replacement, using acetabular reinforcement device with morsellised grafts consisted of autogenous bone chips from the iliac crest, was performed.

Culture on Löwenstein-Jensen medium grew MTB days after inoculation.

Histological examination showed chronic granulomatous inflammation with granuloma formation in the presence of multinucleated giant cells, epithelioid histiocytes, and central noncaseating necrosis.

After cultures were available the patient was commenced on a combination of four antituberculous agents (rifampicin, isoniazid, ethambutol, pyrazinamide), but developed digestive and visual intolerance to ethambutol and pyrazinamide after the first week. He then continued with only rifampicin and isoniazid for 12 months.

Clinically the patient's pain improved. Full range motion was obtained after 3 months and pelvic radiograph showed no signs of prosthetic loosening after two years follow up.

Discussion

Prosthetic joint infection is a serious complication of joint arthroplasty. In patients with joint replacement, the

Table1. Summuary of the reported cases in the literature

Case	Author (Reference),Year		Joint	Time from Arthroplasty to Infection	Medical Therapy And Duration (months)	Surgery	Follow-up	Outcome
1	McCullough et al. [7],1977		Hip	7.8 years	STM(2), INH, RIF(18)	Debridement	6 months	Recovered
2	Bryan et al. [16],1982		Knee	8 years	INH, RIF, EMB (24)	Arthrodesis	3 years	Recovered
3	Zeiger et al. [17],1984		Knee	4 years	NA	Resection Arthroplasty	2 years	Recovered
4	Levin et al. [18],1985		Hip	4 years	STM (3.5), INH, RIF (36)	Resection Arthroplasty	2.5 years	Recovered
5	Wolfgang et al. [24],1985		Knee	1 year	INH, RIF (24)	Staged Exchange	12 months	Recovered
6	Baldini et al. [19],1988		Hip	1,7 years	NA	Resection Arthroplasty	4 months	Recovered
7	Lusk et al. [20],1995		Knee	15 years	INH, EMB, PZA (6)	Resection Arthroplasty	6 months	Recovered
8	Al-Shaikh et al. [21],1995		Knee	8 months	INH, RIF, PZA (12), EMB (9)	Arthrodesis	1 year	Recovered
9	Ueng et al. [22],1995	Case 1	Hip	1.5 years	INH, RIF, EMB (24)	Staged Exchange	3 years	Recovered
10		Case 2	Hip	14 years	INH, RIF, EMB (12)	Resection Arthroplasty	2 years	Recovered
11	Tokumoto et al. [8],1995	Case 1	Hip	38 years	INH, RIF (12)	Arthrodesis	2 years	Recovered
12		Case 2	Knee	1.7 years	INH, EMB (18)	Debridement	8 years	Recovered
13	Kreder et al. [25],1996		Hip	4 years	INH, EMB, PZA (9)	Acetabulum Revised	18 months	Recovered
14	Spinner et al. [11],1996		Knee	4 years	INH, EMB, PZA (9)	Debridement	2.5 years	Recovered
15	Berbari et al. [4],1998	Case 1	Hip	30 years	INH (19), RIF (1), EMB (19)	Resection Arthroplasty	10 years	Recovered
16		Case 2	Hip	23 years	INH, EMB (16)	Resection Arthroplasty	8 years	Recovered
17		Case 3	Hip	10 years	INH, RIF (15)	Staged exchange	7 years	Recovered
18		Case 4	Hip	1 year	INH(12), RIF(7), EMB(9)	Resection Arthroplasty	20 years	Recovered
19		Case 5	Hip	2 years	INH, RIF (39), EMB, STM(6)	Staged exchange	20 years	Recovered
20		Case 6	Hip	3 years	INH(24), RIF (3), EMB (12)	Debridement	8 years	Recovered
21		Case 7	Hip	2 years	INH(24), RIF (6), EMB (24)	Debridement	19 years	Recovered
22	Fernandez-Valencia et al. [23],2003		Hip	6 months	INH, RIF (12), EMB (3)	Resection Arthroplasty	6 years	Recovered
23	Boeri et al. [12] 2003		Hip	24 months	INH, RIF (13), EMB, PZA(4)	No surgery	6 years	Recovered

(Table 1 continued on next page)

(Table 1 continued)

Case	Author (Reference),Year		Joint	Time from Arthroplasty to Infection	Medical Therapy And Duration (months)	Surgery	Follow-up	Outcome
24	Marmor et al. [13],2004	Case 1	Knee	3 months	INH, RIF, PZA (6)	Revision Arthroplasty	7 years	Recovered
25		Case 2	Knee	2 months	INH, RIF, PZA (6)	Revision Arthroplasty	5 years	Recovered
26		Case 3	Knee	4 months	INH, EMB, PZA (8)	Debridement	18 months	Recovered
27	Shanbhag et al. [14],2007		Hip	14 months	RIF, EMB, PYR, PZA (12)	No surgery	18 months	Recovered
28	Wang et al.[10] 2007		Knee	3 years	INH, RIF, EMB, PZA	Debridement	Died	
29	Khater et al.[26] 2007		Knee	3 months	INH, EMB(18)	Rev Arthroplasty	1,5 years	Recovered
30	Lee et al. [15] , 2009		Knee	2 months	RIF, INH, EMB (12)	No surgery	13 months	Recovered
31	Carrega et al. [9], 2009	Case 1	Knee	NA	RIF, INH, EMB (12)	No surgery	12 months	Recovered
32		Case 2	Hip	1 month	RIF, INH, EMB (5)	No surgery	12 months	Recovered
33		Case 3	Hip	NA	RIF, INH, EMB (9)	No surgery	13 months	Recovered
34		Case 4	Knee	2 months	RIF, INH, EMB (12)	Debridement	6 months	Recovered
35		Case 5	Hand	2 years	RIF, INH(12), EMB, PZA(2)	Debridement	1 years	Recovered
36	Mete et al. [5], 2012		Knee	NA	RIF, INH(12), EMB, PZA(2)	Staged exchange	12 months	Recovered
37	Kofteridis et al.[3], 2013		Hip	30 months	RIF, INH(12), EMB, PZA(2)	Revision Arthroplasty	2 years	Recovered
38	Burger et al.[6]. 2013		Knee	2 y	RIF, INH, EMB, PZA(18)	Revision Arthroplasty	2 years	Recovered
39	Montano et al.[27]. 2014		Hip	2 y	RIF, INH(12), EMB, PZA(2)	Revision Arthroplasty	3,5 years	Recovered
40	Present Case. 2016		Hip	14 y	RIF, INH(12)	Acetabulum Revised	1 year	Recovered

infection rate is estimated to be less than 1% for the hip and 2 % for knees [5,6]. The common bacterial causes of prosthesis joint infections are coagulase-negative Staphylococcus, Staphylococcus aureus, aerobic Gram-negative bacilli and anaerobes. M.tuberculosis is a rarely seen cause of prosthesis infection.

PJI due to MTB with no previous history of pulmonary or extra pulmonary TB is a rare complication; only 40 cases are reported in literature (table1). In 1977, McCullough reported the first case of tuberculous infection of a THA seven years after implantation [7].

It can result from either local reactivation or less often from hematogenous spread. Local reactivation can occur as long as 38 years after initial infection and may be related to trauma associated with surgery. The risk for reactivation has been reported to be between 0% and 31%, with TKA (27%) more at risk than THA (6%). [4]. As for hematogenous spread, reactivation at a latent tuberculous site such as the lung, kidney, or mesenteric lymph nodesresults in subsequent seeding of the prosthesis [8].

From the 39 cases reported in the literature, several clinical features emerge. In the majority of these cases, the pa-

tients were over age 50 years (range 25-85 years) and were female (30 female and 10 males). The hip joint was involved in 22 cases and the knee in 18 cases. The time from prosthesis implantation to manifestations of infection was variable, ranging from 1 month [9] to 38 years [8]. Patients usually presented with non specific clinical findings of an infected, painful and malfunctioning prosthesis [3,10].

Inflammatory markers including erythrocyte sedimentation rate (ESR) and CRP were usually elevated to some degree but are non-specific.

In contrast to the reported cases in literature, our patient only suffered from hip pain and presented no inflammatory signs, no fever, and no signs of any infection. Even inflammatory markers (CRP) were found negative. Pain was most likely due to mechanical loosening rather than the infectious process itself; the macroscopic aspect of the intraarticular granuloma was thought to be related to both tuberculous infection and polyethylene induced synovitis.

Diagnosis proved difficult in nearly all the cases. Most importantly this can be attributed to the fact that the initial microbiological investigations did not include specific requests for tuberculosis; which depends on culture and histopathologic examination of tissue; that may reveal acid-fast organisms or caseating granulomas. But granulomas can also represent a reaction to the prosthesis or polyethylene wear debris. Acid-fast stains of the joint fluid are positive in 20-25% of the cases, while cultures are positive in approximately 60 to 80%; histological features are non specific [3,10].

In our case, the discovery of the rice-shaped granules lead us to think of a septic loosening, and therefore to investigate for atypical organisms. Medical management with multidrug antituberculous therapy according to proven sensitivities remains the mainstay of treatment. Duration of therapy is controversial with five months the minimum [9]. The average duration was twelve months.

Surgical treatment depends on the quality of component fixation. If it remains stable components may be retained and medical treatment with or without debridement may suffice. This strategy was done and successful in fifteen cases [4,7-10,11-15]. In the presence of component loosening or secondary bacterial infection, removal and staged revision is advised and achieved satisfactory outcomes in twelve cases [3-6,13,22,24-27]. In twelve other cases, excision arthroplasty was performed [4,8,16-23]. Staged arthrodesis was done in three cases [8,16,21] and is aimed to eliminate the disease but is not without functional problems.

In the present case, acetabular revision was combined with medical management and achieved satisfactory outcomes at 18 months followup.

Conclusions

In conclusion, the present case indicates that in any case of loosening, even when no inflammatory signs are shown, synovium should be routinely examined for pathogenic bacteria including M Tuberculosis, especially when there are atypical features. We can also consider that discovery of such yellowish rice-shaped granules is an indicator to investigate for tuberculosis.

Furthermore, the treatment of the prosthetic joint infection due to M.tuberculosis must involve both medical and surgical approach.

Disclosure

The authors declare that there is no conflict of interest regarding the publication of this paper. For full disclosures refer to last page of this journal.

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Osteoarthritis or Osteoarthrosis: Commentary on Misuse of Terms

Tanchev P[1]

Medical terminology is an important tool for communication among medical practitioners, researchers, and scientists. The precise use of terms ensures a successful orientation in the field of medical practice contributing to the adequate treatment of patients.

The subject of this commentary is the misuse of the terms "osteoarthritis" and "osteoarthrosis" in the specialty of orthopedic surgery. Contemporary literature, journals, media, etc., especially those in English language, are dominated by the use of the term "osteoarthritis" for the most common pathological condition, namely the degenerative joint disease. Leading speakers at prestigious international scientific meetings persistently use the term "osteoarthritis". "Osteoarthritis" is derived from the Greek word part osteo-, meaning "bone", combined with arthritis: arthr-, meaning "joint", and –itis. Strictly taken, this application is incorrect. Because the suffix "-itis" implies the presence of inflammation. Therefore, "osteoarthritis" should be considered misleading since inflammation is not a primary feature of the degenerative joint disease. Here the mechanical stress, avascular necrosis, posttraumatic sequelae, metabolic causes, etc. are the etiopathophysiological factors leading to the process of joint cartilage "tear and wear" (degeneration, noninflammatory breakdown). The term "osteoarthrosis" is correct for degenerative joint disease. Inflammation may play only a secondary or concomitant role in this condition. This is in contrast to rheumatoid arthritis, which is primarily an inflammatory pathologic entity. In short, "osteoarthritis" means inflammation of the joint, while "osteoarthrosis" means degeneration of the joint.

Unfortunately, this terminological misuse and embarrassment in the Anglo-Saxon literature and practice is nourished by some famous medical dictionaries with multiple editions (Dorland's Illustrated Medical Dictionary, Stedman's Medical Dictionary, Stedman's Medical Terminology, etc). [1,2,3] In general, the reader may find the following terms and explanations:

- osteoarthritis - "noninflammatory degenerative joint disease… characterized by degeneration of the articular cartilage, hypertrophy of the bone at the margins, and changes in the synovial membrane…"

- osteoarthrosis – "chronic arthritis of noninflammatory character"

- osteoarthritis – "inflammation of bone and joint", but also "osteoarthrosis is another name for the chronic condition known as osteoarthritis"

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- osteoarthrosis - "chronic, noninflammatory arthritis"

What is it? These definitions are plainly self-contradictory per se. In fact, the attentive reader would just find himself in a terminological trap.

I feel the term "osteoarthritis" is just so ingrained in USA, Great Britain and the other English-speaking countries that there is virtually no chance that it would change. If one would switch to "osteoarthrosis" there, it would likely cause confusion. During some international scientific meetings (where English was the official language) I asked English-speaking colleagues why do they still use incorrectly the term "osteoarthritis" for degenerative joint disease. The answers ranged from habit, cast of mind, tradition, disposition, inertia, etc. to a confusing unwillingness for change. Some colleagues said that trying to change such a popular misuse of medical terminology would be "a lost battle".

Recently, striving to collect some current opinions and provoke a discussion I asked a question on ResearchGate (a social networking site for medical practioners, researcheres and scientists): Why English-speaking colleagues still use incorrectly the term "osteoarthritis" for degenerative joint disease? [4] I received more than 30 thoughtful posts by serious researchers and medical practitioners. And the general opinion was that there was enough evidence for correctional change of this obvious misuse.

I have to underline, that, in contrast, this awkward situation with the terms "osteoarthritis" and "osteoarthrosis" may be juxtaposed on and compared with the never-happening misuse of "spondylitis" instead of "spondylosis", "discitis" instead of "discosis", "periostitis" instead of "periostosis", "osteochondritis" instead of "osteochondrosis" and many other pathological entities where the semantic differentiation corresponds to the etiology, pathophysiology, diagnostics, therapy, etc. With these examples the misuse of terms is unwarranted and unbelievable. They are clearly and correctly defined in the medical literature and practice.

Consequently, the treatment modalities differ significantly.

On the other hand, it should be marked that Russian, German, French and most European orthopedic surgeons refer to the degenerative joint disease as "osteoarthrosis" to signify the lack of inflammatory response. This is historically substantiated ever since the time when the name "Orthopédie" was introduced by the French physician Nicholas Andry in his famous book "L'Orthopédie ou l'art de prevenir et corriger les difformitées du corps chez les enfants" in 1741, in which mechanical overloading was considered to be the main etiological factor for poor body posture, spinal deformity, and joint disorders.

In the 19th century and the first half of the 20th century the practice and theory of European orthopedics were strongly influenced by the French and German textbooks where the denomination "arthrosis deformans" (from Greek/Latin) was predominantly used. This term is still in use in most European countries. However, in the second half of the 20th century, when world medicine came under the strong influence of the Anglo-Saxon literature and science, "osteoarthritis" became the preferred word used for degenerative joint disease..

In fact, osteoarthrosis (in English literature "osteoarthritis") is a degenerative joint disease but may have different origin. The most important point here is what is the primum movens for this variety of pathological conditions. Although primary (idiopathic) osteoarthrosis occurs, the majority of osteoarthrosis types are of secondary nature, e.g. following DDH, intraarticular fractures or cartilage injuries, static disorders, sports overloading, state after femoral head osteonecrosis, metabolic and endocrine disorders, etc. All these are non-inflammatory conditions. The most important pathophysiological factor for degeneration of the joint is the mechanical stress leading to progressive cartilage wear and damage.

Precise terminology is very important, especially in medical practice, where it is directly related to diagnostics and treatment, and consequently to clinical results and outcomes. In fact, some English-speaking surgeons demonstrate some readiness for change. However, the majority remain stubborn explaining the wrong use of term as a bad habit, tradition, disposition, inertia... Bad habits should be subjected to correction. Although the Anglo-Saxon literature is very influential, it is time for repentance, namely a correct use of terms.

Meanwhile, the English-speaking authors started using "OA" for noninflammatory joint diseases. The acronym OA seems to be a "salvage" solution of the existing terminological disturbance. But who can tell what hides behind OA? Probably, it makes things more comfortable and less negligent, but it does not correct the terminological cast of mind. I believe it will only change if we all keep repeating what is correct and what is incorrect. A thought-provoking discussion would be also very useful.

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Levels of Evidence

Reconstructive Review has adopted the American Academy of Orthopaedic Surgeons (AAOS) Levels of Evidence for Primary Research Question. These guidelines will now be part of the review process for manuscript submission.

Levels of Evidence For Primary Research Question[1]

	Types of Studies			
	Therapeutic Studies – Investigating the results of treatment	Prognostic Studies – Investigating the effect of a patient characteristic on the outcome of disease	Diagnostic Studies – Investigating a diagnostic test	Economic and Decision Analyses – Developing an economic or decision model
Level I	• High quality randomized trial with statistically significant difference or no statistically significant difference but narrow confidence intervals • Systematic Review[2] of Level I RCTs (and study results were homogenous[3])	• High quality prospective study[4] (all patients were enrolled at the same point in their disease with ≥ 80% follow-up of enrolled patients) • Systematic review[2] of Level I studies	• Testing of previously developed diagnostic criteria on consecutive patients (with universally applied reference "gold" standard) • Systematic review[2] of Level I studies	• Sensible costs and alternatives; values obtained from many studies; with multiway sensitivity analyses • Systematic review[2] of Level I studies
Level II	• Lesser quality RCT (e.g. < 80% follow-up, no blinding, or improper randomization) • Prospective[4] comparative study[5] • Systematic review[2] of Level II studies or Level 1 studies with inconsistent results	• Retrospective[6] study • Untreated controls from an RCT • Lesser quality prospective study (e.g. patients enrolled at different points in their disease or <80% follow-up.) • Systematic review[2] of Level II studies	• Development of diagnostic criteria on consecutive patients (with universally applied reference "gold" standard) • Systematic review[2] of Level II studies	• Sensible costs and alternatives; values obtained from limited studies; with multiway sensitivity analyses • Systematic review[2] of Level II studies
Level III	• Case control study[7] • Retrospective[6] comparative study[5] • Systematic review[2] of Level III studies	• Case control study[7]	• Study of non-consecutive patients; without consistently applied reference "gold" standard • Systematic review[2] of Level III studies	• Analyses based on limited alternatives and costs; and poor estimates • Systematic review[2] of Level III studies
Level IV	Case Series[8]	Case series	• Case-control study • Poor reference standard	• Analyses with no sensitivity analyses
Level V	Expert Opinion	Expert Opinion	Expert Opinion	Expert Opinion

1. A complete assessment of quality of individual studies requires critical appraisal of all aspects of the study design.
2. A combination of results from two or more prior studies.
3. Studies provided consistent results.
4. Study was started before the first patient enrolled.
5. Patients treated one way (e.g. cemented hip arthroplasty) compared with a group of patients treated in another way (e.g. uncemented hip arthroplasty) at the same institution.
6. The study was started after the first patient enrolled.
7. Patients identified for the study based on their outcome, called "cases"; e.g. failed total arthroplasty, are compared to those who did not have outcome, called "controls"; e.g. successful total hip arthroplasty.
8. Patients treated one way with no comparison group of patients treated in another way.

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