Direct Repair of the Superior Band of Bigelow's Ligament After Hip Arthroplasty: a Surgical Technique

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Abstract *Background:* The posterolateral approach is one of the most common approaches used during hip arthroplasty. A posterior soft tissue repair is necessary to limit the risk of postoperative dislocation. For a trapezoidal capsulotomy, the proximal limb divides the superior band of the iliofemoral ligament (Bigelow's ligament). A transosseous repair frequently leaves a defect in this region, which may elevate the risk for dislocation. The purpose of this article is to describe a simple, rational technique for reinforcing the posterior capsular repair. *Description of Technique:* A meticulous exposure of the hip capsule is performed during the posterolateral surgical approach. A trapezoidal capsulotomy is performed. After implantation of the arthroplasty implants, retractors are placed to expose the superior capsule. Prior to transosseous repair of the

capsule and short external rotator tendons, the proximal limb of the capsulotomy is reapproximated anatomically and repaired with non-absorbable sutures. If anatomical repair is not possible, leg length and femoral offset should be reassessed carefully. *Discussion:* The described modification may further minimize the risk of dislocation following hip arthroplasty, as the superior band of Bigelow's ligament is an additional checkrein to internal and external rotation. This repair provides a secondary intraoperative assessment of leg length and femoral offset to ensure proper biomechanical reconstruction of the hip joint. It is the authors' preferred technique of all hip hemiarthroplasties and total hip arthroplasties, whenever possible.

Keywords hip replacement arthroplasty · hemiarthroplasty · joint capsule · ligaments, articular · hip dislocation

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Introduction

The posterolateral approach for hip arthroplasty is commonly used because of its technical ease, extensile exposure, and minimal effect on hip abductor muscles [14]. Historically, this approach was associated with higher dislocation rates compared to the anterolateral or direct anterior approaches [2]. Patients receiving hip arthroplasty for a diagnosis of femoral neck fracture exhibit particularly high risk for postoperative hip instability [19]. However, if posterior soft tissues are repaired, the dislocation rate following a posterior approach is comparable to other approaches [10, 16].

Numerous methods of soft tissue repair have been described [1, 4, 7–10, 16, 21, 22, 24]. The enhanced posterior soft tissue repair popularized by Pellicci et al. [16] utilizes a trapezoidal capsulotomy and advocates repairing the capsule and short external rotator (SER) tendons in separate layers. At mid-term follow-up, the posterior capsule and SER

tendons are in continuity directly, or through scar, with the greater trochanter in 96% of patients [12]. The soft tissue restraint conferred by this technique is effective at reducing dislocation incidence but does not eliminate it [5, 10]. The combination of hip flexion, adduction, and internal rotation is the most unstable position for a hip arthroplasty undertaken through a posterolateral approach. In this position, the prosthetic head dislocates posteriorly and superiorly, into the interval created by the proximal limb of the capsulotomy. The proximal capsulotomy divides the thickest portion of the hip capsule [23], which lies deep to the gluteus minimus muscle and which includes the superior band of Bigelow's (iliofemoral) ligament [11, 23]. This portion of the ligament contributes to hip stability in both internal and external rotation [11, 23]. Further, magnetic resonance imaging has shown that dehiscence of the posterior capsular repair most frequently occurs proximally [17].

Based upon these observations, a simple, rational technique for augmenting the posterior capsular repair was developed, in which the superior band of Bigelow's ligament is repaired. The purpose of this article is to describe the technique, which should improve anatomical and biomechanical restoration of the hip joint and further reduce the risk of postoperative dislocation.

Surgical Technique

The patient is positioned in the lateral decubitus position and a posterolateral approach to the hip is performed as Pellicci et al. [16] described. Internal rotation of the hip assists releasing the SER tendons and posterior capsule from their native insertions on the femur and maintaining their maximal length [16, 17, 20]. It is important to tag the SER tendons as a layer separate from the posterior capsule; each tendon is tagged with its own suture (Number 2 Ethibond Excel suture, Ethicon Endo-Surgery, Inc., Cincinnati, OH). The plane between the gluteus minimus muscle and the superior capsule is developed with a periosteal elevator prior to capsulotomy, elevating the muscle from deep to its insertion on the femur to the acetabular margin. The proximal limb of the posterior capsulotomy is made deep to the gluteus minimus muscle and parallel to its posterior border, through the thickest portion of the capsule that corresponds to the superior band of Bigelow's ligament [23]. The capsulotomy is carried distally, releasing it along its lateral insertion along the distal femoral neck. Distal release continues until the lesser trochanter can be seen. The posterior capsule is tagged with two non-absorbable sutures, placed approximately 2 cm apart. A horizontal mattress configuration is used in order to minimize shortening of the tissue and not to interpose suture between the capsule and bone, when the transosseous repair is performed.

After implantation of the arthroplasty components and reduction of the hip, two 2.5-mm drill holes are made 2 cm apart in the posterior aspect of the greater trochanter, exiting

medially at the anatomical insertion site for the posterior capsule. Prior to passing the tagging sutures through these drill holes, the proximal limb of the capsulotomy is repaired anatomically:

- Step 1: The hip is placed in neutral abduction and slight internal rotation. A narrow bent Hohmann retractor or C-retractor is placed deep to the gluteus minimus, exposing the superior capsule (Fig. 1a).
- Step 2: A heavy non-absorbable suture is used to approximate the superior capsule to the proximal limb of the capsulotomy (Fig. 1b). The superolateral corner of the capsular flap should be advanced maximally to avoid shortening the capsule and compromising the transosseous repair. If the capsule cannot be approximated easily or if the tissues appear redundant, leg length and femoral offset should be reexamined critically considering the preoperative goals for both parameters.
- Step 3: The suture is tied in figure-of-eight fashion (Fig. 1c). Additional sutures may be applied, if necessary, to close the interval but usually are not required.
- Step 4: The capsule and SER tagging sutures are passed through the drill holes and tied to each other, completing the transosseous posterior soft tissue repair (Fig. 1d).

The remainder of the closure then proceeds in the standard fashion.

Discussion

Dislocation remains an important consideration after hip arthroplasty, affecting approximately 2% of patients receiving modern implants [6]. It is the second most common reason for THA revision, representing 14.1% of primary THA failures [18]. Patient-specific variables influencing hip arthroplasty stability include patient age, gender, and comorbid conditions [19]. However, surgical technique, restoration of leg length and femoral offset, femoral head-to-neck ratio, and component positioning are important factors within the surgeon's control that can impact the incidence of dislocation [5, 16]. The modification described herein augments the traditional two-layer enhanced soft tissue repair [16], through a direct repair of the superior band of Bigelow's ligament, which reinforces the proximal portion of the capsular repair.

After a posterolateral approach, dislocation can be attributed to persistent dead space or disturbance of the posterior soft tissue envelope, with repair failure and creation of a soft tissue defect. The proximal transosseous repair dehisces more often than its distal aspect [17]. Furthermore, the combination of hip flexion, adduction, and internal rotation dislocates the prosthetic head posteriorly and superiorly. The modification described closes the proximal limb of the trapezoidal capsulotomy, which represents a defect in superior band of Bigelow's ligament.

Fig. 1. Intraoperative photographs illustrate the surgical technique. **a** The proximal capsular defect is shown prior to repair; a bipolar hemiarthroplasty component can be seen through the defect. **b** A single non-absorbable suture is placed in figure-of-eight fashion through proximal limb of trapezoidal capsulotomy. **c** The suture is tied, completing the proximal capsulorrhaphy and repair of the superior band of Bigelow's ligament. **d** The final soft tissue repair is shown before the fascia is closed; the capsule and external rotator tagging sutures have been fed through the drill holes. *White arrow* indicates two drill holes made in the posterior aspect of the proximal greater trochanter with passing sutures fed through each. *White asterisk* indicates the posterior capsular flap, tagged with two sutures. *Black asterisk* indicates the short external rotators, each tagged with non-absorbable suture; they are reflected posteriorly in Fig. 1a–c to show the capsule. *White arrowhead* indicates the superior edge of the capsulotomy.

The iliofemoral ligament is primarily an anterior structure, but Walters et al. [23] demonstrated that its superior band expands superiorly and laterally. This band contributes to the hip capsule, where it is most thick in the posterior-superior quadrant of the hip, beneath the gluteus minimus muscle [23]. Further, although the ischiofemoral ligament is the primary ligamentous restraint to internal rotation, Martin et al. [11] showed that the superior band of Bigelow's ligament provides additional stability to the hip joint in both internal and external rotation. Therefore, repairing this structure should serve to create further biological restraint to dislocation.

Attention toward the tension or laxity of the repair assists restoration of hip joint biomechanics, and improved soft tissue and biomechanical reconstruction may mitigate the risk for postoperative hip instability. However, the description of this modified technique is limited, since clinical results were not available. A comparative trial is necessary to definitively support its theoretical advantages. Assuming that the baseline incidence of dislocation is approximately 2% [6], over 3600 patients are needed to design a two-armed study with 80% power to detect a 50% reduction in the incidence of dislocation using an alpha level of 0.05 and assuming no loss to follow-up [3].

A variety of alternative soft tissue repair techniques have been described in the literature to minimize the risk of dislocation following hip arthroplasty [1, 4, 7–10, 16, 21, 22, 24]. Most techniques fail to address the superior defect in the trapezoidal capsulotomy. In part, this is because most soft tissue repair techniques are described in the context of total hip arthroplasty (THA). To facilitate acetabular exposure during THA, the anterior-superior aspect of the capsule is often released, along with the indirect head of the rectus femoris muscle [15]. Therefore, the described modification may not be performed easily during THA. Additionally, compared to hip hemiarthroplasty, THA may deliberately alter limb length and femoral offset, making the modification impossible without compromising the transosseous capsular repair.

Dixon et al. [4] attempted to close the posterior-superior defect by rotating and suturing the lateral margin of the capsular flap to the posterior gluteus medius tendon but did not advocate the repair of the SER tendons. Other authors have described a soft-tissue-only repair of the capsule and external rotators that reapproximates the piriformis and the posterior capsule back to the anterior-superior capsule and the posterior border of the gluteus minimus in one layer to repair the superior defect [1]. The former technique leaves posterior dead space once occupied by the SER tendons, and if the SER tendons are repaired, additional torque is required for dislocation [13]. The latter technique eliminates this posterior dead space; however, releasing the capsule and overlying SER tendons in one layer makes it more difficult to preserve their maximum length and to restore appropriate soft tissue tensioning during closure. Both techniques leave a persistent defect between the capsule and trochanter and violate the basic surgical principle of restoring native soft tissue planes. Additionally, both place sutures through the abductor muscles, which are otherwise spared during a posterolateral approach. Alternatives to our technique that also anatomically repair the capsule use a T-shaped capsulotomy [4], U-shaped capsulotomy [22], or a double-door incision [7]. However, these techniques divide the capsule through some of its thinnest portions [23], which may not provide optimal anchorage for repair sutures. They are also complex in preparation and rely on numerous sutures to achieve similar capsular integrity.

In the authors' experience, the technique described is a practical modification of the posterior soft tissue repair with particular relevance to hip arthroplasty undertaken through a posterolateral approach. It is most easily performed for hip hemiarthroplasty but is applicable to select THA, in which the superior capsule is not released completely and hip biomechanics are not significantly altered. Empirical and radiographic evidence informs the rationale that supports repairing the superior band of Bigelow's ligament, which may provide additional biological restraint to postoperative dislocation and improved biomechanical reconstruction of the hip joint.

Compliance with Ethical Standards

Conflict of Interest: Joseph Liu, MD; Alexander S. McLawhorn, MD, MBA; Alexander B. Christ, MD; Peteris Dzenis, MD; and John H. Healey, MD, have declared that they have no conflict of interest.

Human/Animal Rights: This article does not contain any studies with human or animal subjects performed by the any of the authors.

Informed Consent: N/A

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