

Synthetic Ligaments in Hip Surgery

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Abstract

Synthetic ligaments have been used in orthopaedics for nearly a century. After a wave of popularity in the early 1980s, particularly for treating the knee, they fell into disrepute due to the frequent and often severe complications, particularly when used intra-articularly. Subsequent advances in the materials, design and manufacture of synthetic ligaments have led to a renaissance in their popularity. They are routinely used in knee, shoulder, elbow and ankle surgery, and have recently been described to have a role in hip surgery. We explore the background of synthetic ligaments and their applications around the hip in both primary and revision surgery.

Keywords

Synthetic ligaments, hip, abductors, short external rotators, revision

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Ligament replacement or augmentation with synthetic materials is an accepted part of orthopaedic practice. Synthetic materials have a long history of use, particularly around the knee, where they have been used to repair or replace both intra- and extra-articular ligaments. They are also used extensively around the shoulder to repair rotator cuff tears and acromio-clavicular joint dislocations. Other joints now routinely reconstructed with synthetic ligaments include the ankle, elbow and, recently, the hip.

Ligament reconstruction surgery dates from the early 1900s, when Corner¹ described replacing a ruptured anterior cruciate ligament (ACL) with silver wire. It was not until the 1980s that it became a popular technique, following the approval of Dacron®, Gortex® (polytetrafluoroethylene) and the Kennedy Ligament Augmentation Device (polypropylene) for general orthopaedic use. The lack of donor-site morbidity, earlier return to function and limitless supplies were cited as advantages over autograft techniques. These initial materials acted as prostheses designed to permanently replace the ligament. Unfortunately, these materials were stiff with low ultimate tensile strengths and poor abrasion properties. Not only did grafts fail after cyclical loading, but also marked synovitis² and cartilage destruction from the wear particles was noted when used intra-articularly. These significant side effects markedly limited the popularity of synthetic ligaments in the late 1980s and 1990s.

The second generation of synthetic ligaments that followed were designed to act as scaffolds, providing initial strength following reconstruction but relying on biological in-growth of native tissues in order to provide longevity. Although they encourage biological integration, they are not joint-specific and concerns have been raised about the quality of the collagen that grows onto these scaffolds on account of the stiffness of the polyethylene.³

The current generation of synthetic ligaments are highly engineered, being both ligament- and joint-specific while also incorporating biological function. The current generation of ACL ligaments are sided, with woven ends to enable fixation into bone tunnels and unwoven intra-articular portions to prevent abrasion of the articular cartilage and third-body wear. Initial results of the use of these third-generation ligaments have been encouraging in terms of both restoration of joint function and fewer and less severe side effects.⁴

Basic Science

First-generation synthetic ligaments were found not to be bio-compatible, and in fact produced quite severe inflammatory reactions. Both second- and third-generation materials have addressed these concerns by using bio-compatible materials such as polyethylene washed in collagen. This encourages fibroblastic adhesion and later differentiation into native tissue. These newer materials have stress-strain characteristics that more closely resemble the natural ligament, and have often been tested up to 10 million cycles. The breaking strength of these materials is such that it is usual for the fixation method to be the rate-limiting step in terms of graft survival.

Applications in Hip Surgery

Dislocation

The first description of a synthetic ligament being used around the hip was to prevent recurrent dislocation following total hip replacement (THR).⁵ The ligament was used as a static leash, anchored to the edge of the acetabulum with a screw and secured around the prosthesis neck like a noose. This restricted the arc of movement of the prosthesis, hence preventing dislocation. The obvious drawback was reduced movement; however, it was mooted as a less radical treatment than complete revision of both components. A wide variety of revision implants and techniques have limited this indication to a select group of patients.

Figure 1: Bare Trochanter**Figure 3: Ligament Sutured onto Short External Rotators****Figure 2: Ligament Sutured onto Abductors****Figure 4: Securing Ligament Through Intra-osseous Tunnels**

Abductor Mechanism Repair

A bare trochanter is a lesion similar in pathology to a rotator cuff tear in the shoulder (see *Figure 1*).⁶ It is occasionally seen during an anterolateral approach to the hip, but may also be diagnosed with a magnetic resonance imaging (MRI) scan or ultrasound when investigating trochanteric bursitis. It is a recognised cause of hip pain and abductor weakness leading to a Trendelenberg gait. The anterolateral approach involves detaching the abductor mechanism of the gluteus medius and minimus from the greater trochanter. One of the recognised complications of this approach is a Trendelenberg gait resulting from a poor abductor repair. The rate of Trendelenberg gait varies according to the reports of various authors, but is often quoted as around 1–5%. Lubbeke⁷ quotes a re-exploration rate of 1% for failed repair following hip arthroplasty, although the true number of failed repairs – whether symptomatic or not – is probably far higher. This group reported a substantial improvement of hip function in fewer than half of patients.

A more traditional repair without using synthetic ligaments was undertaken. This is similar to Weber's experience;⁸ however, he did report that those patients operated on for instability had substantial improvement in their instability symptoms.

Small defects in the gluteus medius can be repaired by suturing the abductors onto the bare area. Larger native defects or those resulting from failed repair at the time of primary THR require a different strategy. The use of suture anchors has been described as a technique to repair the abductors back onto the greater

trochanter following THR. However, complications of failed repair and symptomatic osteolysis⁹ have prevented it from becoming a widely accepted technique. Second-generation ligaments such as the Graft Jacket (Wright Medical) have been used to repair these defects, but as they are predominantly flat sheets of material they have an inherent weakness at the point of attachment onto the greater trochanter. Third-generation ligaments have recently been used to address this problem.¹⁰ An example of this is the Ligament Augmentation and Reconstruction System (LARS hip ligament, Corin Group), modified from its initial role in rotator cuff repairs of the shoulder. It is a trouser-shaped ligament with a flat proximal end and two tubular distal limbs. Its breaking strength is 1,500N. Its principal benefit is that it allows a secure fixation onto bone through intra-osseous tunnels.

Undoubtedly the most suitable application for synthetic ligaments occurs during revision hip surgery. Regardless of the surgical approach used, either from the primary surgery or from the revision procedure, one of the principal challenges to the revision surgeon is presented by the loss of native tissue, be this bone or soft tissue. If native tissue is still present, it may be scarred, retracted or contaminated with polywear debris. The surgeon has a dichotomy. To achieve an adequate debridement often compromises the soft-tissue repair. Synthetic ligaments can be utilised to bridge these defects, be they posterior where the short external rotators (SERTs) were or anterior where the abductors were. The broad-shaped end of the ligament is sutured onto the remnants of the gluteus medius tendon. The two limbs of the Y-shaped ligament are attached onto

the proximal femur through intra-osseous tunnels secured with interference screws. The ends of the ligament are tied onto each other to reinforce the reconstruction (see *Figure 2*).

Short External Rotator Repair

The posterior approach to the hip involves detaching the SERS from the medial aspect of the greater trochanter. Repair of the SERS contributes to the stability of THRs. The dislocation rate with the posterior approach is higher than that of the anterolateral approach. Historically, SERS have not always been repaired, but it is now standard practice. They are usually repaired with intra-osseous sutures. If the offset of a THR is substantially increased from that of the native hip, as is often the case with severe degenerative disease or protrusio hips, repair of the SERS can be challenging. If the soft-tissue contractures remain after simple releases and cannot be approximated to the trochanter, a synthetic ligament reconstruction is indicated. Typically, this involves suturing the broad, flat end of a purpose-made implant onto the muscles (see *Figure 3*), with the two distal tubular limbs secured with interference screws into intra-osseous tunnels (see *Figure 4*). This offers a theoretical but as yet unproven reduction in dislocation rates.

Revision Hip Surgery

Undoubtedly the most suitable application for synthetic ligaments occurs during revision hip surgery; however, regardless of the approach used, from either the primary surgery or the revision procedure, one of the principal challenges to the revision surgeon is presented by the loss of native tissue, be it bone or soft tissue. If the native tissue is still present, it may be scarred and retracted or contaminated with polywear debris. The surgeon has a dilemma to achieve an adequate debridement often compromises repair of the soft tissue. Synthetic ligaments can be utilised to bridge these defects, be they posteriorly where the SERS were located or anteriorly where the abductors were located.

Limitations

Obviously, concerns exist when inserting additional material around a hip when it has been revised for an infection. The integration of the allograft with native tissue could theoretically be challenging to remove should it become infected, and many surgeons would consider an infected revision a relative contraindication.

As expected with most highly developed orthopaedic implants, the synthetic ligaments are not cheap, although their manufacturers would argue about their cost-effectiveness: third-generation implants can cost up to £1,500. Clearly, for a primary THR this has a significant cost implication for the procedure, but it becomes a smaller percentage when expensive revision implants are factored into the costings.

Conclusion

As the technology of synthetic ligaments has improved and the lessons from the first-generation ligaments have been learned, so has the willingness of the orthopaedic community to embrace them. There appears to be a renaissance in their popularity, particularly among surgeons treating younger and higher-demand patients. As with all new orthopaedic treatment modalities and applications, the challenge is to provide the scientific evidence of benefit over existing modalities. The broad range of indications for synthetic ligaments around the hip makes this challenge so much greater. ■



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1. Corner EM, Notes of a case illustrative of an artificial anterior crucial ligament, demonstrating the action of that ligament, *Proc R Soc Med*, 1914;7:120–21.
2. Indelicato PA, Brown HR, Gore-Tex prosthetic ligament in anterior cruciate deficient knees, *Knee surgery: Current Practice*, 1992:298–304.
3. Moyer B, Artificial ligaments for anterior cruciate replacement, *J Bone Joint Surg (Br)*, 1994;76-B:173–5.
4. Nau T, Lavoie P, Duval N, A new generation of artificial ligaments in reconstruction of the anterior cruciate ligament, *J Bone Joint Surg (Br)*, 2002;84-B:356–60.
5. Barbosa JK, Khan AM, Andrew JG, Treatment of recurrent dislocation of total hip arthroplasty using a ligament prosthesis, *J Arthroplasty*, 2004;19(3):318–21.
6. Bunker TD, Esler C, Leach W, Rotator-cuff tear of the hip, *J Bone Joint Surg Br*, 1997;70-B:618–20.
7. Lubbeke A, Kampfen S, Stern R, Hoffmeyer P, Results of surgical repair of abductor avulsion after primary total hip arthroplasty, *J Arthroplasty*, 2008;23(5):694–8.
8. Weber M, Berry D, Abductor avulsion after primary total hip arthroplasty: Results of repair, *J Arthroplasty*, 1997;12(2) 202–6.
9. Harwin S, Osteolysis of the greater trochanter: A result of bone anchors used for abductor reattachment at total hip arthroplasty, *J Arthroplasty*, 2006;21(1):97–101.
10. B Holroyd, Fern ED, The novel use of a Lars ligament around the hip, *Ann R Coll Surg Engl*, 2008;90:253–4.

Editor's Recommendation

Minimally Invasive Total Hip Arthroplasty: A Systematic Review

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The purpose of this study was to compare the operative outcome between mini and standard incisions in total hip arthroplasty (THA). The authors identified 12 randomised or quasi-randomised controlled trials (RCT or qRCT) published between 1996 and 2008. Subgroup and sensitivity analyses were performed to evaluate the differences in results for surgical approach, trial quality and follow-up duration. Operative time and blood loss were significantly reduced in the mini-incision group for studies with the posterior or

posterolateral approach. Concerning post-operative complications, there were no significant differences between the two groups with no significant heterogeneity. No differences were observed between the two groups for Harris hip score and radiographic results except for cup anterversion. Although mini-incision appeared to have similar outcomes to standard incision, the follow-up is short-term according to current standards in THA. High-quality studies are required to compare the outcomes of these two procedures. ■