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Complications of the Latarjet procedure

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Abstract The Latarjet procedure is an operation performed either arthroscopically or open for recurrent anterior shoulder instability, in the setting of glenoid bone loss; with good to excellent functional results. Despite excellent clinical results, the complication rates are reported between 15 and 30 %. Intraoperative complications such as graft malpositioning, neurovascular injury, and graft fracture can all be mitigated with meticulous surgical technique and understanding of the local anatomy. Nonunion and screw breakage are intermediate-term complications that occur in less than 5 % of patients. The long-term complications such as graft osteolysis are still an unsolved problem, and future research is required to understand the etiology and best treatment option. Recurrent instability after the Latarjet procedure can be managed with iliac crest bone graft reconstruction of the anterior glenoid. Shoulder arthritis is another complication reported after the Latarjet procedure, which poses additional challenges to both the surgeon and patient.

Keywords Latarjet · Graft osteolysis · Dislocation arthropathy · Neuropraxia · Graft malpositioning · Nonunion

Introduction

Traumatic anterior shoulder instability is a common problem with a reported incidence of 24 per 100,000 persons/year [1, 2]. The most common age group for first-time shoulder dislocation is seen in males between the second and third decades of life [2]. Traumatic shoulder dislocation may lead to damage of the soft tissue or bony structures, thereby disrupting the congruent arc of motion. It is very important to identify the soft tissue lesion and ascertain the extent of glenoid and humeral bone loss. Surgical management of shoulder instability consists of procedures ranging from an intraarticular arthroscopic repair such as a Bankart repair or an extraarticular open procedure such as a Latarjet procedure. Deciding on the right procedure for a particular patient is often challenging. Various scoring systems are proposed to guide the clinician choosing the correct operation for the patient [3]. It is important to take into consideration the patient's age, physical demand, mechanism of injury, and the extent of glenoid bone involvement.

With a Bankart repair, the aim is to reinforce/repair the damaged anterior capsulo-labral complex. A Bankart repair has a reported failure rate of 13 % at 2 years. This ranges from 4 to 19 % as reported by various authors [4]. It is well understood that glenoid bone loss contributes to a significantly higher failure rate after Bankart repair [5]. It is also well established that a soft tissue repair alone is inadequate for a patient with glenoid bone loss of grater than 20 % of the glenoid width; a so-called inverted pear glenoid is an indication for a bony procedure such as a Latarjet procedure.

An open procedure involving transfer of the coracoid process to the anterior glenoid rim for recurrent anterior instability of the shoulder was first described by Michel Latarjet in 1954 [6]. This open procedure has been refined over time to achieve good long-term results [7]. This procedure transfers the coracoid to the glenoid rim and enhances the shoulder stability by its triple-block effect. Firstly, the increased bony surface area increases the congruent arc of motion. Secondly, the conjoint tendon provides a dynamic sling effect in abduction and external rotation. Thirdly, repair of the capsule increases anterior stability. The rate of recurrent instability after

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a Latarjet procedure is reported to be around 1 % [8–11]. However, there has been concern of a higher surgical complication rate associated with the Latarjet procedure. A recent, large systematic review reported an overall complication rate in the open Latarjet procedure of 15 % [12]. Other reports have reported surgical complication rates as high as 25 % [13] and 30 % [14]. It is important to note that meticulous surgical technique and a good understanding of the local anatomy help reduce the complications of the Latarjet procedure. In this chapter, we discuss the various complications reported in literature for the Latarjet procedure and aim to provide the reader with optimal management options for each reported complication.

Intraoperative complications

I. Graft-related complications

1. Malpositioning

(a) Too high
(b) Too low
(c) Too medial
(d) Too lateral

2. Graft fracture

II. Nerve injury

1. Suprascapular nerve
2. Axillary nerve
3. Musculocutaneous nerve

III. Vascular injury

Postoperative complications

I. Immediate postop

1. Hematoma
2. Subcutaneous swelling

II. Delayed postoperative

1. Infection
2. Neuropraxias
3. Brachial plexopathy

III. Long-term complications

1. Nonunion
2. Osteolysis
3. Recurrent instability
4. Arthritis

Intraoperative complications

Graft-related complications

The correct position of the graft remains disputed. However, there is consensus that the graft should be positioned between the 2 o'clock and 5 o'clock position on the glenoid face (right shoulder) and should be positioned just medial to the chondral surface of the glenoid (Figs. 1 and 2).

Malpositioning

Accurate positioning of the graft is one of the most critical steps of the procedure. However, even in experienced hands, correct position remains challenging due to the limited exposure and visualization of the anterior inferior glenoid. The arthroscopic Latarjet has the potential advantage of enabling a global visualization of the glenoid from different portals, thereby minimizing incorrect graft placement.

Too high Hovelius et al. noted a 36 % incidence of malpositioned grafts located above the equator in their case series [15]. This could lead to recurrent instability [15–17]. Too high a graft also increases the risk of malpositioning of the superior screw and causing an iatrogenic suprascapular nerve injury [18, 19]. The overall reported incidence of this injury remains very low, with a few case reports [20, 21]; however, the senior author (LL) believes that the actual incidence is much higher than what is reported in the literature.

Fig. 1 Graft placement

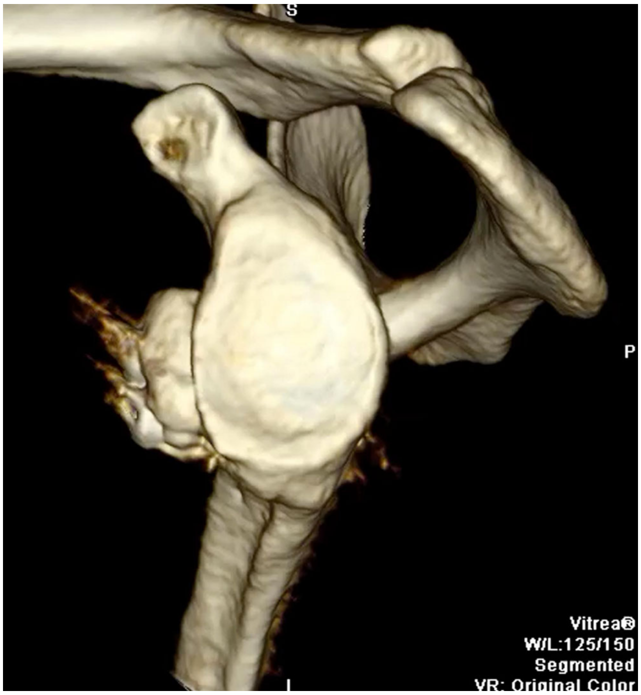

Fig. 2 Graft placement

Too low This may predispose to a fibrous nonunion as often there is insufficient space for the inferior screw to purchase in the glenoid; the single superior screw is unable to provide rotational stability there by creating a weak biomechanical construct [22].

Too medial Medial graft positioning has a reported incidence of around 5–6 % [15, 23]. However, this may be underreported as the extent of graft medialization remains contentious. Most authors would agree that the graft should be positioned at the level of the glenoid subchondral plate. A graft placed too medial will eliminate the bone block effect and might lead to recurrent instability.

Too lateral The rate of lateral overhang has been reported in the order of 10–53 % of Latarjet cases [23, 24]. It is well understood that lateral overhang is an independent risk factor for secondary osteoarthritis [15, 25] and thus should be avoided at all costs.

Graft fracture

The coracoid measures around 21±2 to 26±2.9 mm in length [26, 27]. The average thickness is 9.3±1.3 mm. Care must be taken during graft harvest and preparation. Excessive decortication of the undersurface of the coracoid weakens the graft and may predispose to an iatrogenic graft fracture. The reported rate of graft fracture is 1.5 % [28]. Secondly, care must be taken to space the drill holes wide apart. The minimum distance in between the screws is not well established. Walch et al. [27] noted in their cohort the mean distance to be 7.8±1.9 mm. Lafosse et al. [29] have utilized a specific coracoid jig (Mitek, USA) to optimize the distance between the screws to 9 mm, when this jig is utilized. The screw holes should be tapped before insertion of the definitive screws, and a washer or a plate may be utilized in osteoporotic bone. It must be noted that excessive tightening of the screws may lead to screw head (partially threaded cancellous screws) penetration into the coracoid graft and may lead to the screw perforation and catastrophic failure of fixation.

In the case of an intraoperative coracoid fracture, a few options exist. A decision needs to be made bases on the quantity and quality of bone remaining in the fractured graft.

- Transverse fractured graft, in good quality bone, if sufficient bone is available and the single screw has a good bite, can be augmented with a smaller screw or a bioabsorbable anchor. In cases of a screw hole blowout, a buttress plate can be used and screws are inserted through the small plate to provide compression. The Di Giacomo plate (Arthrex Inc., Naples, FL) is such an option.
- For a longitudinal graft fracture or in very osteoporotic bone, an iliac crest bone graft (Eden-Hybinette) is an option. The iliac crest is prepared and a 2-cm bicortical or tricortical graft is harvested. This is then fixated to the glenoid neck (two screws) with the cortical surface facing medially and the soft cancellous surface facing laterally.

Nerve injury

In a systematic review, Griesser et al. reported a 1.4 % rate of neurovascular injury across open and arthroscopic techniques [14]. There were 11 musculocutaneous nerve injuries, of which 2 were either partial or temporary, while 9 were either partial permanent or complete injuries resulting in nerve deficit. Of the 6 axillary nerve injuries, 2 were permanent while 4 were temporary. There were 4 trunk-level brachial plexopathies, 3 of which resulted in permanent deficit. Warner and co-authors found a 10 % rate of nerve palsy after open Latarjet in a series of 48 shoulders [13]. These were two axillary nerve palsies, two musculocutaneous nerve palsies, and one radial nerve palsy. The musculocutaneous and radial nerve palsies resolved over a number of months, but the two cases of axillary nerve palsy remained symptomatic and both ultimately underwent neurolysis, with some limited symptomatic relief. Delaney et al. further characterized the neurologic complications by performing a neuromonitoring study of the open Latarjet procedure [20, 30]. In a study cohort of 40 patients undergoing a Latarjet procedure with an articulated traction device, median somatosensory evoked potentials (SSEPs), transcranial motor evoked potentials (TcMEPs), and free electromyogram (EMG) were measured intraoperatively. The contralateral SSEPs, TcMEPs, and EMG were measured as control. The mean follow-up was 1 year. The authors reported 7 clinical axillary nerve deficits (20.6 %) postoperatively, 3 sensory neuropraxias, 3 sensory neuropraxias with deltoid weakness, and 1 deltoid weakness without sensory deficit. All patients made complete neurological recovery. The authors reported the high-risk stages of the Latarjet procedure were the glenoid exposure and coracoid graft placement. A long surgical operating time of 106 min was noted to be a cofactor due to prolonged retraction. This study has demonstrated the importance of avoiding traction and keeping the glenoid retraction to a minimum as important steps to prevent iatrogenic axillary nerve injury.

The management of nerve injuries is expectant. Postoperatively at the 2-week follow-up visit, if a nerve deficit is noted, it is documented and a detailed neurological examination is performed. A CT scan of the shoulder is attained to evaluate for correct screw placement and graft positioning. If there is no radiological abnormality noted, the patient is reassured. Follow-up is at 6 weeks and 3 months. If no improvement is noted at the 3 months' follow-up, an EMG is obtained to evaluate the extent of the injury. At 6 months' follow-up, if no recovery is noted, the patient is referred to a specialist brachial plexus unit for an evaluation. Management options at this stage include nerve transfers and muscle flaps.

Vascular injury

In a systematic review, Griesser et al. reported a 1.4 % rate of neurovascular injury across open and arthroscopic techniques [14]. These involved six cases of axillary artery injury (five pseudoaneurysms and one intraoperative laceration). Each was treated with appropriate revision vascular surgery.

Postoperative complications

Immediate postop

Hematoma

Hematoma is an uncommon complication of the arthroscopic Latarjet procedure. Needless to say, meticulous hemostasis during the procedure obviates this complication. Often, a rebleed occurring due to hypertension can cause a hematoma. In cases of an arthroscopic Latarjet, the hematoma may be identified around days 3–4 (once the swelling caused by fluid subsides). This may be distressing for the patient. Generally, admission to the hospital, cold packs, oral analgesia, and reassurance are all that is required. Very rarely, progressively enlarging hematomas require surgical drainage and an angiogram to rule out arterial injury.

Subcutaneous swelling

Postoperative swelling is normal and occurs in all the patients after the arthroscopic Latarjet procedure. Typically, the swelling subsides by the end of the first postoperative week. It is important to note that the swelling is localized to the respective shoulder and part of the hemothorax. Swelling extending into the neck or the contralateral hemothorax should cause immediate concern, and the patient must be monitored in a high-dependency setup. Low pump pressure with continuous outflow, efficient and short operating time, and a hypotensive anesthetic are important to prevent excessive sot tissue insufflation.

Delayed postoperative complications

Infection

As with any shoulder surgery, there is a risk of infection after open or arthroscopic Latarjet. In a series on short-term complications of this procedure, Warner et al. found a 6 % incidence of superficial infection [13]. All three cases resolved with irrigation and debridement and antibiotic therapy. In cases of deep infection, it may be necessary to remove the screws to facilitate complete eradication of the infection. The patient may also need a prolonged course of intravenous antibiotics and infectious disease consultation. Infection may lead to failure of the coracoid graft and recurrence of instability, in which case the infection is managed with appropriate antibiotic therapy after adequate irrigation and debridement. Subsequently, when the infection has been definitively cleared, a revision procedure to restore stability, such as the Eden-Hybinette procedure, may be undertaken.

Neuropraxias

Musculocutaneous nerve Southam et al. reported a delayed transient musculocutaneous nerve (MCN) palsy 13 months after the index procedure [31]. The author postulated that the palsy was a result of relative lengthening of the MCN due to the Latarjet procedure and a recent history of rigorous mechanical work (using a sanding device and 4 h of all terrain driving). Bach et al. [32] described a case of delayed MCN and ulnar nerve paresthesia in a swimmer. The patient presented with acute pain and an audible snap while swimming 2 years after the index procedure. The screw was noted to have backed out. The screw was removed with good pain relief; the graft was noted to be well united. Two years later, the patient represented with persistent numbness and tingling in the fourth and fifth fingers and an audible bruit with abduction of the arm. The patient underwent a surgical exploration, and the MCN was noted to enter the conjoined tendon 1.5 cm from the transferred coracoid and was trapped in prominent scar.

Anatomic changes in the position of the MCN after the Latarjet procedure are well documented. Freehill et al. [33] in their cadaveric study demonstrated that the MCN became medial and inferior to its original location. In another study, Clavert P [34] noted a relative lengthening of the MCN nerve and a change in the penetration angle (121°–136°) by 15° into the conjoint tendon.

In the senior author's (LL) experience of over 500 arthroscopic Latarjet procedures, he has not encountered this complication; the delayed MCN palsy remains a well-documented albeit rare complication of this procedure.

Suprascapular nerve Transient suprascapular nerve (SSN) palsy is well documented [20]. Special attention should be paid to the direction of the superior screw. The mean distance of the superior screw's exit site to the SSN (at the base of the scapular spine) has been shown to be 4 mm [18]. Maldirected screws (towards the scapular spine) might lead to entrapment of the infraspinatus branch of the SSN. Shishido et al. [19] estimated a safe zone of drilling from the anterior glenoid rim. An angle of <28° of medial tilt in the axial plane and <29° of inclination in the caudocranial direction (coronal plane) was safe to avoid inadvertent injury to the SSN.

If a suprascapular nerve injury is noted in the first 2 weeks of postoperative follow-up, this is managed by an urgent CT scan to evaluate the position of the screws. If the superior screw is long and incorrectly positioned, then the patient is booked for an urgent removal of this screw and insertion of another screw in a more caudal direction. If the CT scan demonstrates correct placement of the screw, then the patient is monitored for clinical recovery.

Brachial plexopathy

Historically, a high number of brachial plexus lesions have been reported [35]. This was attributed to poor knowledge of local anatomy, utilizing the axillary approach, not identifying the MCN nerve intraop, and also poor exposure to the anterior inferior glenoid. This complication is extremely rare in both open and arthroscopic Latarjet procedures.

Implant related

The use of screws close to the glenohumeral joint can pose problems [36]. Of the 7 % reoperation rate found in a systematic review by Griesser et al., 35 % were for removal of symptomatic hardware or malpositioned screws [14]. This can be related to screw loosening, prominence in the joint, or breakage. Prominent intraarticular screws or graft malposition with lateral overhang can lead to glenohumeral arthritis.

In the senior author's experience, the patients present with pain and focal tenderness anterior to the shoulder especially with external rotation with the arm in adduction. This pain is attributed to the screw head rubbing against the subscapularis muscle in a consolidated graft. This can be easily dealt with by removal of the screw via either an open or arthroscopic technique.

Long-term complications

Nonunion Coracoid nonunion is a recognized complication of the Latarjet procedure (Fig. 3). In most cases, this is a found on routine radiographic images during the follow-up visit of patients in clinic. The patients often have good to excellent functional results with an incidental finding of nonunion. Very rarely does a nonunion require a reoperation.

In a recent systematic review by Griesser et al. [14], an analysis of 45 studies (1904 shoulders) demonstrated 174 cases of nonunion or fibrous union, an overall nonunion rate of 9.1 %. Walch et al., in their cohort of 68 patients with a mean follow-up of 20 years, have reported a fibrous nonunion rate of 1.5 % with no recurrence of instability [2]. Lafosse et al. [26], in their 5-year review of 62 patients, noted 1 patient (1.7 %) required a reoperation as a result of graft nonunion. The undersurface of the coracoid graft should be decorticated as well as the anterior inferior glenoid rim to a flat surface; in addition, the two screws should be placed parallel to the glenoid face to minimize the risk of nonunion of the graft.

Osteolysis In a CT analysis study of 26 patients, Di Giacomo et al. found a mean of 59.5 % osteolysis of the coracoid graft

Fig. 3 Nonunion and screw breakage

[37]. This extensive osteolysis was not found to be of any great clinical significance in terms of recurrence of instability. The osteolysis was most commonly seen in the superficial part of the proximal coracoid, while the deep portion of the distal region of the graft was the least involved in osteolysis and exhibited the best rates of bone healing. In a subsequent paper, Di Giacomo and co-authors demonstrated that the coracoid graft underwent significantly less osteolysis in patients with anterior glenoid bone loss compared to those without glenoid bone loss (39.6 vs. 65.1 %, respectively, $p<0.01$) [37]. The authors concluded that in cases without significant bone loss, the coracoid graft undergoes so much osteolysis that the stabilizing effect of the Latarjet procedure must be due to other components of the technique (sling effect, capsular effect). This therefore implies that the complication of coracoid graft osteolysis is usually a radiologic finding with little to no clinical significance in terms of recurrence of instability or functional outcome, and therefore does not require any specific management. If the osteolysis results in implant problems such as the screws becoming prominent, this can be managed as discussed above. In the rare case where coracoid graft osteolysis results in recurrence of instability, this is managed as described above with revision to an Eden-Hybinette procedure or allograft reconstruction.

Instability Recurrence of instability after the Latarjet procedure may be related to technical error by the surgeon, including errors of graft placement, or to postoperative trauma or to patient factors such as voluntary dislocations, ligamentous laxity, or seizure disorders. Additional risk factors for recurrence include graft avulsion, subscapularis failure, and graft lysis. Fibrous union of the graft has not been shown to contribute to the recurrence of instability [23, 38].

One large series reported a 5 % redislocation rate and 96 % patient satisfaction [39]. Other large series of greater than 1000 Latarjet procedures have reported instability recurrence rate of 1 % [38, 40]. In a recent long-term study with a mean of 20 years' follow-up, Walch et al. reported a recurrence rate of 5.9 % [7]. Hovelius et al. reported a recurrence rate of 18 % when the procedure was performed without a capsular shift, decreasing to 4 % when a horizontal capsular shift was added to the technique [39]. The same authors found that coracoid graft position on the glenoid was a significant factor in recurrence of instability, with 83 % of patients whose graft was positioned 1 cm or more medial to the glenoid rim having a recurrent dislocation postoperatively.

Management of recurrent instability after the Latarjet procedure often involves a technically demanding salvage procedure, made difficult by the revision nature of the procedure and the scar tissue from prior surgery. Outcomes may be compromised by pre-existing arthritis, which can develop after the index surgery.

The most common salvage procedure for failure of a Latarjet procedure is the modified Eden-Hybinette procedure, in which an iliac crest bone graft is placed on the anterior glenoid rim through a subscapularis split [41]. A bicortical, wedge-shaped graft is harvested from the ipsilateral iliac crest for placement on the anterior glenoid. This can be carried out as an open or an arthroscopic procedure.

In the arthroscopic technique as described by the senior author (LL), the iliac crest graft is harvested from the ipsilateral iliac crest. The shoulder arthroscopy is commenced and the rotator interval is opened. The quality of the chondral surfaces is noted. The graft remnant is excised and the glenoid neck is burred using a high-speed burr. The medial surface subscapularis is dissected; care is taken not to stray too medial as this might endanger the plexus. The subscapularis split is made (junction of superior two thirds and inferior one third), and the old screws are removed. The iliac crest graft is positioned in the desired position and fixated with two partially threaded cancellous screws using the Mitek Latarjet system.

In a large published series of the Eden-Hybinette procedure as a salvage operation for failed open Latarjet procedure, four out of 34 patients (12 %) had a recurrent dislocation after revision [41]. Ten patients (29 %) had arthritis at the latest follow-up, but only four of these did not have pre-existing arthritis prior to the revision procedure. Overall in this series, there were six excellent, 21 good, three fair, and four poor results according to the modified Rowe score.

Arthritis A potential long-term consequence of the Latarjet procedure is glenohumeral arthritis [7, 39] [2, 8]. Walch reported that the rate of development of arthritis after the open Latarjet procedure was 20 % at 20 years [7, 2]. In the eight patients who had pre-existing arthritis related to their shoulder instability events, progression of arthritis was seen in four of them (50 %). With a multivariate logistic regression analysis, older age at the time of final follow-up, high-demand sports, and lateral overhang of the coracoid graft were significantly associated with postoperative arthritis. In a prospective analysis of radiographs of 115 shoulders at 2 and 15 years after an open Latarjet procedure, Hovelius et al. found moderate or severe arthropathy in 14 % and mild arthropathy in 35 %, according to the grading system of Samilson and Prieto [42, 43]. The most significant predictor of arthropathy was found to be age of 23 years or older at first dislocation. Longo et al. found in a systematic review that there was no significant difference between rates of osteoarthritis after bone block procedures and Bankart repairs [12]. The major limitation of any study attempting to quantify arthropathy after the open or arthroscopic Latarjet procedure is that it is very difficult to distinguish the natural evolution of dislocation posttraumatic arthropathy from arthropathy related to the surgical procedure.

Older patients (approximately 60 years and above) with arthropathy after a Latarjet procedure can be managed in accordance with the standard approach to glenohumeral arthritis.

The management of glenohumeral arthritis in the younger patient remains a major challenge in modern shoulder surgery [44]. Initial pain relief and functional improvement are usually excellent after total shoulder arthroplasty; however, these gains are short-lived in the younger population, with a dramatic decline in functional outcome and survival rate at 10 years' follow-up compared to 5 years [45]. Younger patients have a higher rate of glenoid component loosening, likely related to higher activity levels, and therefore, alternative strategies have been sought. Hemiarthroplasty has been used as an alternative, with limited benefit in the long term, likely due to unaddressed glenoid disease. The senior author does not perform the ream and run procedure as described by Dr. Matsen. Biologic resurfacing of the glenoid in conjunction with hemiarthroplasty has yielded disappointing results [46–48]. Comprehensive arthroscopic management of arthritis includes glenohumeral chondroplasty; removal of loose bodies; humeral osteoplasty and osteophyte resection; anterior, posterior, and inferior capsular release; subacromial decompression; axillary nerve neurolysis; and biceps tenodesis. This can result in symptomatic relief [49]. However, these effects are temporary and results are unpredictable. Furthermore, this technique does not provide a definitive solution for the advanced-stage posttraumatic glenohumeral arthritis.

Summary

The Latarjet procedure is a well-established and time-tested procedure for the management of glenohumeral instability with an overall complication rate between 15 and 30 %. It has a low rate of recurrent instability <5 % with excellent functional outcomes. The neurological and vascular complications of this procedure can be minimized with good surgical technique and knowledge of the local anatomy. Functional outcome is not compromised in the setting of coracoid graft nonunion or osteolysis. However, precise graft positioning and graft osteolysis remain unsolved challenges and further areas for research. Shoulder arthritis may be seen in patients after the Latarjet procedure, which poses addition challenges to the surgeon and patient.

Compliance with ethics guidelines

Conflict of interest Ashish Gupta and Kalojan Petkin declare that they have no conflict of interest.

Ruth Delaney has received paid travel accommodations from DePuy/Mitek.

Laurent Lafosse has received consultancy fees, royalty payments, and payment for development of educational presentations and has a patent with DePuy/Mitek.

Human and animal rights and informed consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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