Safety and efficacy of arthroscopy in the setting of shoulder arthroplasty

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Abstract Shoulder arthroplasty has become a reliable and reproducible method of treating a range of shoulder pathologies including fractures, osteoarthritis, and rotator cuff arthropathy. Although most patients experience favorable outcomes from shoulder arthroplasty, some patients suffer from persistent symptoms post-arthroplasty and it is these patients who present a unique diagnostic and therapeutic challenge. The role of arthroscopy in assessing and treating patients with symptomatic prosthetic joints elsewhere in the body has been established in recent literature. However, the range of pathology that can affect a prosthetic shoulder is distinct from the knee or the hip and requires careful and considered assessment if an accurate diagnosis is to be made. When used alongside other investigations in a comprehensive assessment protocol, arthroscopy can play an important role in the diagnosis and treatment of the problematic shoulder arthroplasty.

Keywords Shoulder arthroscopy · Shoulder arthroplasty · Periprosthetic infection · Rotator cuff

Introduction

Shoulder arthroscopy is a key tool in the diagnostic and therapeutic armamentarium of an orthopedic surgeon. In particular, its utility in treating a wide range of intra-articular and extra-articular conditions, such as rotator cuff damage [1], labral injury [2], and biceps tendinopathy [3], has been well described in surgical literature. The use of arthroscopy in the setting of shoulder arthroplasty, however, has been less extensively evaluated. As implant design improves and the number of indications for performing arthroplasty in the shoulder expands, more and more patients with symptomatic shoulders post-arthroplasty will require specialist assessment [4•]. In this potentially challenging patient population, the potential for shoulder arthroscopy to diagnose and treat causes of post-arthroplasty shoulder pain must not be overlooked. A significant body of literature exists describing arthroscopy in total knee arthroplasty for a wide range of indications, including tethered patella syndrome [5], arthrofibrosis [6], and even periprosthetic infection [7], and indications for arthroscopy in the setting of total hip arthroplasty have been comprehensively reported in the literature recently [8]. As evidence recommending performing shoulder arthroscopy following shoulder arthroplasty is scant, the safety and effectiveness of this procedure on different patient populations must be evaluated. It is hypothesized that additional research into shoulder arthroscopy will prove it to be an effective and safe procedure for the treatment of the symptomatic patient post shoulder arthroplasty.

Indications

Although some indications for arthroscopy of non-shoulder prosthetic joints are transferrable to the shoulder as well

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(e.g., pain with no clear diagnosis [9] established), arthroplasty of the shoulder is a unique procedure that has its own unique set of technical challenges. Some unique complications including glenohumeral instability, glenoid or humeral component malpositioning/loosening, and rotator cuff damage/subscapularis failure exist [4•]. The shoulder is the only joint in which the articular surface components are interchangeable, i.e., total shoulder arthroplasty (TSA) vs. reverse total shoulder arthroplasty (RTSA), with each of these presenting unique and distinct challenges in both the index surgery and subsequent post-operative assessment [10].

The main factors to consider when establishing a diagnosis in painful prosthetic shoulder patients are the following: (1) Why was the arthroplasty performed? (e.g., degenerative joint vs. trauma), (2) What type of arthroplasty was performed? (e.g., hemiarthroplasty vs. TSA vs. RTSA), and (3) Was it a primary or revision shoulder arthroplasty? There are numerous technical considerations related to implant position and alignment, signs of implant failure and loss of joint congruity that must also be addressed during the initial assessment. Assessing these factors within the context of the index arthroplasty is essential to making the correct diagnosis [11].

Pain with no clear diagnosis

If definitive diagnoses for pain can be established using this systematic approach for assessment, and the appropriate treatment for the definitive diagnosis is an open surgical procedure, then these patients do not require arthroscopic evaluation. This would represent unnecessary surgery and may even delay definitive care undesirably. When the diagnoses remain elusive despite non-operative treatment modalities to improve it (e.g., physiotherapy, pain modalities, etc.), patients should be considered for arthroscopic evaluation of their prosthetic joint [12].

Patients presenting with persistent pain following arthroplasty of the shoulder often represent a significant diagnostic challenge. First-line investigations of these patients should include plain film radiographic evaluation of the joint to assess component position, visible evidence of hardware failure (e.g., infraglenoid notching, humeral and/or glenoid osteolysis), intra-articular loose bodies, or periprosthetic fractures [5]. Cross-sectional imaging is often of limited benefit due to metal artifact generated by the in situ prosthesis [13]. If no pathology is evident, one must then consider the possibility of a non-indicated previously unappreciated injury and clinically assess the rotator cuff for any obvious deficiencies. This may prove difficult, however, if the shoulder is stiff or the prosthesis limits the patients' range of motion. Clinical assessment of the pain in this scenario would be limited and therefore decrease diagnostic accuracy.

Periprosthetic infection

As with any prosthetic joint, periprosthetic joint infection (PJI) must always be investigated for with serum laboratory tests such as a complete blood count (CBC), erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP) [14•].

Diagnosing periprosthetic infections in any joint represents a unique diagnostic challenge [15]. The shoulder, however, is unique in its clinical and microbiological presentation of infection involving a prosthesis. Traditionally, an image-guided aspiration of fluid from the joint and subsequent analysis of the sample was considered the gold standard in achieving a diagnosis of PJI [16]. Recent evidence has challenged the reliability of this method when compared with arthroscopic retrieval of intra-articular tissue samples [17•] in achieving a confirmed PJI diagnosis.

Impingement syndrome/rotator cuff injury

In some cases, patients who have undergone total shoulder arthroplasty (TSA) or humeral hemiarthroplasty have been shown to develop impingement syndrome [19] that can be reliably diagnosed clinically with physical examination maneuvers and subacromial lidocaine injection testing [18]. In these patients, arthroscopic acromioplasty has been described as an alternative to an open acromioplasty [18]. While arthroscopy in these patients avoids a second invasive open procedure, it does present a technical challenge of addressing the rotator cuff injury while avoiding damaging the prosthetic components. Cross-sectional imaging can create imaging artifact that prevents accurate diagnosis of a rotator cuff tendon tear. Alternatively, ultrasound scans can be utilized to confirm the presence of a rotator cuff tendon tear as they are not as limited by the same imaging artifact.

Loose body/component removal

As has been previously described in both the hip [19] and knee [20], loose bodies of varying origins (e.g., cement pieces, bone fragments) have been reported in the literature as being removable via arthroscopy, avoiding an invasive second open procedure. Removing the loose bodies alleviates mechanical symptoms as well as minimizes abrasion damage to the prosthetic components. Arthroscopy has even been utilized in the removal of loose components such as the glenoid [21]. To our knowledge, no literature exists describing replacement of prosthetic components via arthroscopy, meaning a subsequent open procedure is likely in this context.

Since the use of arthroscopy in prosthetic shoulder joints is in its infancy, no professional consensus statements on the subject are available. However, when it is clear that definitive treatment will require an open procedure, arthroscopy should be considered redundant and therefore relatively contraindicated.

Safety

Many of the important safety considerations are common to all shoulder arthroscopy procedures, irrespective of whether the joint is native or prosthetic. For example, patient positioning has been discussed at length in the literature and the risks of both beach chair and lateral decubitus positions comprehensively reviewed [22]. Arthroscopic fluid management must be considered, with higher flow rates and pressures increasing the risk of fluid extravasation and subsequently increasing the risk of iatrogenic compartment syndrome [23].

Safety aspects unique to arthroscopy in the setting of arthroplasty include care in maneuvering the arthroscope to avoid excessive contact with the components—micro-abrasions in arthroplasty components have been reported and are thought to confer adverse wear properties to the component material [24]. Careful maneuvering of the arthroscope may be difficult in the presence of adhesions, increasing the level of technical challenge. Bonutti et al. [25] described the “mirror phenomenon” that can cause disorientation during arthroscopy that may lead to the aforementioned damage to the components or even the arthroscope itself. Similarly, Dallari et al. [26] describe a case of broken instrumentation during arthroscopy of a prosthetic hip that required arthroscopic retrieval and excision during the arthroscopic procedure. The level of surgeon training and skill in this technique is especially important in mitigating these circumstances.

In a review of the literature describing arthroscopy in shoulder arthroplasty, “Indications and Outcomes of Shoulder Arthroscopy after Shoulder Arthroplasty,” the pooled data revealed 84 patients (Table 1) underwent arthroscopic surgery, of which only two patients in one report experienced complications related to the surgery. One patient experienced a periprosthetic fracture that was treated immediately with open reduction and internal fixation, and the other patient had a deep post-arthroscopic infection [27]. This

resulted in a complication rate of 2.4 % (2/84) which is comparable to the described complication rate in arthroscopy of hip arthroplasty of 3.2 % (5/154) [8]. It is important to note that these statistics are described when a highly skilled surgeon with a wealth of experience performing arthroscopy undertook arthroscopy of all prosthetic joints. Technical factors such as arthroscopic fluid pump settings must also be optimized to minimize the risk of developing complications related to extravasation of the fluid outside of the shoulder joint—lower flow and pressure settings are recommended. Soft tissue compromise related to index surgery dissection will also increase the risk of fluid extravasation, meaning arthroscopic intervention must await complete soft tissue healing from the index procedure and must not be performed acutely post-operatively.

As with arthroscopy of native shoulders, safety of the procedure depends on both patient and surgeon factors, with the added dimension of implant factors also influencing safety. In this unique setting, it is preferable for a senior surgeon experienced in arthroscopy to perform the procedure due to the significant technical challenge it represents. Implant factors such as implant type (i.e., hemiarthroplasty vs. total shoulder arthroplasty), implant or component size, and position will all contribute to the level of difficulty encountered when assessing the joint arthroscopically. For example, a humeral component with a large head and placed superiorly within the joint may present a challenge in maneuvering the arthroscope within the joint, whereas a reverse shoulder arthroplasty shifts the entire joint space laterally, altering the surgeons ability to orientate the arthroscope relative to anatomical landmarks.

Efficacy

In the few instances where authors have described settings in which arthroscopy of prosthetic shoulders was performed, interpretation of the procedure’s effectiveness is more difficult to interpret. “Indications and Outcomes of Shoulder Arthroscopy after Shoulder Arthroplasty” showed that up to 44 % of patients who undergo arthroscopy of a prosthetic shoulder will require further surgery, usually in the form of an open debridement and/or major prosthetic revision. To better understand the reason behind this significant re-operation rate, a detailed analysis of individual indications would need to be performed—a significant number of patients in the review received arthroscopy in order to diagnose a periprosthetic joint infection for which the current gold standard treatment is open revision arthroplasty [16]. This indication is therefore unique in that successful diagnosis of infection from the arthroscopic biopsy results in subsequent open surgery, whereas the purpose of arthroscopy performed for other

Table 1 Indications for arthroscopy in prosthetic shoulders

Indication	% of patients in review (<i>n</i> = 84)
Pain and/or loss of ROM NYD	39.3 (33)
Rule out infection	25.0 (21)
Impingement syndrome	19.0 (16)
Adhesive capsulitis	9.5 (8)
Glenoid loosening	7.1 (6)
Rotator cuff tear	3.6 (3)
Subscapular nerve abnormalities	1.2 (1)
Posterior shoulder instability	1.2 (1)
Loose body	1.2 (1)
Septic joint	1.2 (1)

indications is to treat the conditions encountered to avoid further open surgery.

Pain with no clear diagnosis

The primary purpose of arthroscopy in patients with painful shoulders with no clear diagnosis is to evaluate the joint to establish a diagnosis. Therefore, surgical success is characterized by identification of a potential cause for the pain that was not evident from previous investigations. Both Bonutti et al. [25] and Hersch et al. [15] report case series where patients underwent diagnostic arthroscopy for this reason and concluded that all patients who underwent arthroscopy achieved a diagnosis as a result of the procedure. Establishing whether these diagnoses were the correct ones is more difficult to prove—Bonutti et al. [25] did not specifically report any formal outcome measure, but stated that “all (9) patients returned to their pre-arthroscopy level of activity within 2 weeks.” Hersch et al. [15] did report Hospital for Special Surgery (HSS) functional outcome score as their outcome measure and noted statistically significant improvement in HSS score post-arthroscopy, implying that the diagnoses achieved via arthroscopy were accurate and the subsequent treatment of each patient was appropriate and successful.

Periprosthetic infection

Dilisio et al. [17•] performed a study where 19 patients underwent arthroscopic tissue biopsy of prosthetic shoulders suspected of being infected, as well as image-guided aspiration of the glenohumeral joint. Each of the samples was sent for culture analysis and then compared to open tissue biopsy samples taken at the time of open revision surgery. The arthroscopically obtained samples yielded a 100 % sensitivity and specificity, whereas the glenohumeral aspirate obtained under imaging guidance yielded only 16.7 % sensitivity with a 100 % specificity. The results of this study are striking, and although the limitations of its selection bias have been commented on in the literature [28], it highlights the sensitivity of shoulder arthroscopy in the diagnosis of periprosthetic joint infection. While further study in this area is required to establish precisely if arthroscopy should be prioritized for diagnosing shoulder PJI, it has been shown to be effective in achieving a diagnosis in this patient population [17•].

Impingement syndrome/rotator cuff injury

Arthroscopic subacromial decompression in the setting of shoulder arthroplasty has been reported by Tytherleigh-Strong et al. [29] with favorable results. The authors reported Constant-Murley shoulder scores for both pre- and post-arthroscopy in a cohort of 16 patients that received arthroscopic subacromial decompression. The mean improvement in Constant score was 37 and statistically significant. They also report similar findings [29] in a cohort of 21 patients who underwent arthroscopic subacromial decompression and capsular release—exhibiting a significant mean improvement in Constant score of 38. Statistically significant improvement in functional outcome scores for all 16 patients indicates arthroscopic subacromial decompression is effective in treating impingement syndrome in the setting of shoulder arthroplasty.

While interpreting data detailing efficacy of a procedure, it is important to realize that efficacy in most cases is being extrapolated from studies of low methodological quality with small cohorts in mostly retrospective case series. Further high-quality studies are needed to robustly test the hypothesis that if shoulder arthroscopy is effective in each of these contexts. From the literature thus far, shoulder arthroscopy can be an effective method for the management of the symptomatic shoulder arthroplasty (Table 2).

Conclusion

Despite a limited number of studies investigating the potential for shoulder arthroscopy in aiding diagnosis and/or therapeutic intervention following arthroplasty, the literature generally reports favorable outcomes for the varying indications. Pain with no clear diagnosis, periprosthetic infection, intra-articular loose bodies, and rotator cuff tendinopathy have all been successfully treated in the literature utilizing arthroscopy. Current data suggests that it is both safe (relative to complication rates among other periprosthetic arthroscopic procedures) and effective when used as part of a comprehensive clinical assessment methodology, including appropriate laboratory investigations and imaging modalities. Further clinical study would ideally highlight patient populations and contexts where

Table 2 Summary of findings for safety and efficacy of arthroscopy in shoulder arthroplasty

Indication	Periprosthetic infection	Pain—no clear diagnosis	Impingement syndrome/rotator cuff tear
Safety (complication rate, %)	0.0	0.0	12.5
Efficacy (% successfully diagnosed/treated)	100	97	87.5

arthroscopy of prosthetic shoulders can be most appropriately and effectively implemented.

Compliance with ethical standards

Conflict of interest Sebastian Heaven, Darren de SA, Andrew Duong, Nicole Simunovic, and Olufemi R. Ayeni declare that they have no conflict of interest.

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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