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Abstract

The number of total shoulder arthroplasty (TSA) and reverse total shoulder arthroplasty (RTSA) procedures performed each year has continued to rise. While these procedures were historically done in the inpatient setting, many surgeons have migrated to performing TSA and RTSA in the outpatient setting. This can either involve sending patients home the same day from the hospital or performing these in an outpatient center. Specific protocols should be followed in regard to patient selection to minimize the risk of complications and readmission. Similarly, a team approach between the anesthesiologist and the surgeon is critical to ensure adequate pain control. Use of tranexamic acid (TXA), a preoperative nerve block as well as specific combinations of preoperative and postoperative medications are helpful in creating an optimal environment in which to perform the shoulder arthroplasty for the patient. When done well, TSA and RTSA can successfully be performed as an outpatient with a very high success rate and a low risk of complications.

Keywords: total shoulder arthroplasty (TSA), reverse total shoulder arthroplasty (RTSA), outpatient, hospital, surgical center, shoulder, arthroplasty, ambulatory, complication, readmission, outcome

1. Introduction

The number of total shoulder arthroplasty (TSA) and reverse total shoulder arthroplasty (RTSA) procedures performed each year has continued to rise, and will continue to rise as the population ages and lives longer (Figure 1) [1–3]. While shoulder arthroplasty has historically been performed in the inpatient setting, over the several years, many surgeons have moved to performing TSA/RTSA in the outpatient setting. Performing shoulder arthroplasty in the outpatient setting decreases cost to the healthcare system as well as provides an excellent patient experience. Recent studies have shown excellent results with few complications in patients who have undergone outpatient TSA/RTSA [4–7]. However, not every patient is a candidate for an outpatient shoulder arthroplasty.
2. What patients are eligible for outpatient shoulder arthroplasty?

While a great many patients are candidates for TSA and RTSA, not every patient is a candidate for a shoulder arthroplasty in an outpatient setting. First, some patients may not be comfortable having surgery in an outpatient center and some insurance companies may not be accepted by the outpatient center. In these cases the surgery should be done in the hospital setting. It also helps if patients have a good home support system to help them with activities of daily living following surgery. While they will be able to do many things on their own, there will be some things that they will likely need help with. There are many services an outpatient center does not have that a hospital has, so patients at increased risk for complications, bleeding, breathing issues, etc. should not have their shoulder arthroplasty done in an outpatient center.

The authors have developed criteria to determine whether patients are good candidates for shoulder arthroplasty in the outpatient setting.

From a medical perspective, patients who are American Society of Anesthesiology (ASA) 1 and 2 are often eligible. Occasionally patients who are ASA 3 are eligible, but this should be a case-by-case decision. Patients under 65 years of age are often better suited for an outpatient arthroplasty, although older, high functioning patients can be good candidates as well. Patients should be off chronic narcotics before having an outpatient shoulder arthroplasty and must be willing to participate in a multimodal pain management program. Furthermore, the patient should be a good candidate for a regional block for pain control. The following is a list of relative contraindications to patients having their TSA/RTSA in an outpatient setting. Any patients who have conditions on this list may require a proper medical/cardiology and anesthesia evaluation preoperatively.

- Cardiac
- Significant heart disease
- Poor LVEF (<50%)
Outpatient Total Shoulder Replacement Procedures
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- Ischemic heart disease, stents
- CHF
- Arrhythmia
- Valve replacement
  - Chronic anticoagulation is a relative contraindication and the decision may be individualized based on circumstances of case
- Obesity with BMI > 40
- Diabetes with A1C > 8–9
- Chronic Anemia with HG < 10
- Substantial OSA
- Renal insufficiency (creatinine > 1.6)
- COPD or pulmonary hypertension
- Chronic liver disease
- Neurologic issues
  - CVA or significant neurologic illness
  - History of frequent falls
  - History of cognitive dysfunction (dementia, Parkinson’s)

3. How to successfully perform an outpatient shoulder arthroplasty

3.1 Before surgery

There are several keys to a successful outpatient shoulder arthroplasty. Two of the most important issues surrounding outpatient shoulder arthroplasty are pain control and infection prevention. There are several pieces to pain control including preoperative, intraoperative and postoperative pain management. First, patients undergoing outpatient shoulder arthroplasty are premedicated in the preoperative area prior to surgery. Typically, the authors use 1000 mg of Acetaminophen, 300 mg of Neurontin, and 200 mg of Celecoxib all given orally. The patients are also given regional anesthesia, typically a supraclavicular or interscalene block. The medication used by the anesthesiologist for the block should include a long-acting local anesthetic such as Bupivacaine. Some facilities have moved to using an even longer acting anesthetic such as Bupivacaine liposome injectable suspension (trade name: Exparel), although this can sometimes be cost prohibitive. From an infection prevention
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perspective, patients are asked to wipe the operative site twice daily with benzoyl peroxide beginning 2 to 3 days prior to surgery and continuing this up until surgery. This helps decrease the C. Acnes load on the skin. Finally, from a timing perspective, it is important to schedule these patients early in the day so they have adequate time to recover before going home. Performing an outpatient arthroplasty later in the day can be tricky and runs the risk that the patient may need to stay overnight.

3.2 Intraoperative

Once the patient has received their block and preoperative medications they are brought back to the operating room where they are given general anesthesia (Figure 2). A general anesthetic allows for muscle relaxation which facilitates exposure during a shoulder arthroplasty. To minimize the amount of time the patient is under anesthesia and to mitigate infection risk, it is important to perform the TSA/RTSA efficiently.

Figure 2. After general anesthesia, the patient is positioned, draped, and secured in the modified beach chair position.
As such, it is important for the surgeon to be comfortable with TSA and RTSA procedures before attempting these in the outpatient setting (Figure 3). Having major delays during the procedure keeps the patient under anesthesia for a longer time and may increase the likelihood that they will not go home after surgery. Furthermore, revision TSA/RTSA are not typically performed in the outpatient setting as these patients often have more pain, lose more blood, and have longer operative times than primary cases (Figure 4). As surgeons get comfortable with sending patients home the same day following TSA/RTSA, we recommend surgeons perform these cases in an inpatient setting to begin with and send the patients home the same day. Once they have successfully sent these patients home the same day they can progress to performing these cases in the outpatient setting.

Prior to incision the patient should be given 1 g of IV Tranexamic acid (TXA). This acts as a clot stabilizing agent (it is not prothrombotic) and will help minimize blood loss during the procedure. Cvetanovich et al. performed a prospective, double-blind,
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placebo-controlled, randomized clinical trial where patients undergoing primary TSA and RTSA were randomized to either receiving 1 g of IV TXA or a placebo to determine if TXA reduced blood loss [8]. The authors included 108 patients (52 for TXA, 56 for placebo) who had no significant differences in preoperative characteristics. They found that the TXA group had significantly lower postoperative blood loss compared with the placebo group. They also found that TXA had lower weight of hemoglobin loss compared with placebo. Similar results were seen in the total knee and total hip arthroplasty literature [9–12]. Similarly, Gillespie et al. randomized 111 patients who underwent shoulder arthroplasty to receive topical saline or topical saline mixed with 2 g of TXA into the wound at the conclusion of the case and measured postoperative drain output (patients at the time of this study all received a drain. This is not done anymore) [13]. The authors found significantly less blood loss in the TXA group compared to the placebo group (108 mL vs. 170 mL) as well as a greater drop in hemoglobin level in the placebo group compared to the TXA group (2.6 g/dL vs. 1.7 g/dL). As such, we routinely use TXA in all of our outpatient shoulder arthroplasty procedures.

Once the preoperative antibiotics (2 g Cefazolin) and Tranexamic acid have been administered, the TSA/RTSA is performed in the standard fashion. The patient is prepped with a hydrogen peroxide wash to decrease the load of C. Acnes on the skin prior to their chlorhexidine prep [14]. The authors use a deltopectoral approach (Figure 5). As previously mentioned, exposure is key in TSA and RTSA, so it is important to ensure each layer of dissection is complete to avoid shrinking the operative field. The authors perform a subscapularis peel on all TSA and RTSA (Figure 6). Adequate releases on both the humeral and glenoid side will help facilitate glenoid exposure so this is imperative to avoid issues with glenoid pin placement. Once the humeral head cut is made and the glenoid is adequately exposed, the authors use a patient specific guide to place the glenoid pin. A preoperative CT scan is obtained on all patients prior to TSA and RTSA and is unloaded into a preoperative planning software (Virtual Implant Positioning (VIP) Arthrex, Naples FL USA) (Figure 7). The ideal glenoid position can then be planned out, and a reusable guide is used to

Figure 5.
An example of a deltopectoral incision used in outpatient procedures.
Once the glenoid component is secured the final humeral implant is placed. The subscapularis is either repaired using a suture anchor repair technique in TSA (SpeedScap, Arthrex, Naples FL, USA) or in transosseous manner with high tensile sutures in RTSA. Based on evidence from the total knee and total hip arthroplasty literature, once the subscapularis has been repaired, it is important to allow the shoulder to soak in dilute betadine for 5 minutes to help decrease the risk of infection [15, 16]. Some surgeons do not allow betadine into operative field as they believe betadine can “burn” tissues. In the author’s opinion, this has not been an issue and the addition of betadine has helped mitigate infection risk. Once the dilute betadine has had time to sit it is irrigated out. Next, 1 g of Vancomycin powder is placed in the incision, part just over the subscapularis
and part over the deltopectoral closure [17–21]. A running absorbable stitch is used to close the skin along with skin glue. A waterproof silver impregnated dressing is utilized to decrease infection risk [22]. During the case the anesthesia team should ensure adequate patient hydration to avoid postoperative dehydration.

3.3 Postoperative

Following surgery patients are given a set or oral medication including 1000 mg of Acetaminophen, 300 mg of Neurontin, and 200 mg of Celecoxib. If patients are experiencing pain, medications including ketorolac, oxycodone, or tramadol can be utilized on an as needed basis. Ondansetron should be used to control postoperative nausea. A second dose of IV TXA can be given in the recovery room before discharge. A second dose of antibiotics (2 g Cefazolin) is not routinely used unless it has been more than 8 hours since the preoperative dose and the patient has not gone home. Patients are not sent home with any antibiotics. Patients are sent home with a multimodal pain regimen. Further work is needed to determine the ideal combination of medications, but some of the options to include are: Acetaminophen, Tramadol, Oxycodone, Gabapentin, Celecoxib, Aspirin and Pantoprazole.

3.4 Physical therapy

The demand for shoulder arthroplasty is projected to exceed that of hip/knee arthroplasty [23]. For instance, it has been reported that a total of 39,072 patients were admitted for total shoulder arthroplasty in 2010, 5 times the number of patients in 1998 [24]. This increase is proportionally associated with the need for effective and feasible physical therapy, which is critical in the recovery pathway following shoulder replacements [25]. Traditionally, physical therapy following shoulder surgery has occurred via in-office supervised visits [26]. Home-based physical therapy reduces costs and decreases the need for travel [27]. Home-based therapy has been shown to be as effective as in-office therapy after total knee arthroplasty and has been utilized for rehabilitation after proximal humerus fracture [28–30]. It has also been reported to be a safe and effective alternative in the early phase following rotator cuff repair [31]. However, home-based therapy lacks the ability to monitor patient performance, compliance, and progress. Digital health has been incorporated in various medical fields over the past few decades. This process has accelerated since the COVID-19 pandemic which has brought to the forefront of medicine the need to deliver care and rehabilitation remotely. Remote patient monitoring has emerged as a concept in which patient physiologic parameters are measured and remotely delivered to a care team. Within our practice, remote patient monitoring is implemented via a secure cloud-based provider rehabilitation platform that communicates with a patient application powered by marker-less artificial intelligence (AI) technology with a dedicated built-in telemedicine capability (PT Genie; Orlando, FL) (Figure 8).

At the initial visit patients are instructed on how to use the platform and are provided a QR code to scan and download the app onto their device (Android/iOS). PT Genie has instructions on the home-based exercise protocol, demonstrates the exercises to be performed and keeps track of progress including pain score, completed repetitions and number of sessions all via the AI driven sensor less motion tracking using the front facing camera of a cellphone or a tablet. Monitoring is performed on
the web-based clinical dashboard by a dedicated care team, who also monitor the daily progress and communicate with the patients via in-app messages, telemedicine calls, and emails (Figure 9). PT Genie allows the provider to fully customize and control the rehabilitation protocol by adding or modifying exercises to go along with the patient's pace of recovery, the addition of bands and calculation of force on certain exercises, and the ability to set up a prehabilitation phase, if needed prior to surgery.

Figure 8.
The patient-facing application (PT Genie) which tracks ROM using AI marker-less technology.
4. Results of outpatient shoulder arthroplasty

Several studies have shown the efficacy of outpatient TSA and RTSA compared to inpatient shoulder arthroplasty. Cimino et al. performed a systematic review of 12 studies (194,513 patients, of whom 7162 were outpatients) to evaluate the outcomes following outpatient TSA and RTSA [32]. The average age of the outpatients was 66.6 years while the average age of the inpatients was 70.1 years. The authors found the odds ratio for complications was significantly lower in outpatients than in inpatients. Furthermore, there was no significant difference in rates of 90-day readmission, revision, and infection rate between outpatients with inpatients. Similarly, Fournier et al. reported the results of 61 patients who underwent outpatient TSA and RTSA [6]. There were no cardiopulmonary events that required intervention or hospital admission. These studies evaluated both TSA and RTSA together. This happens commonly because the CPT code for TSA and RTSA is the same (23472). Below are examples of studies that separated outcome based on TSA and RTSA.

i. TSA

Erickson et al. reported the results of 94 patients (average age 60.4, 67.0% male) who underwent TSA 2015–2017 by the senior author. The authors matched this group of patients to a group of 77 patients who underwent TSA as an inpatient. Patients who underwent outpatient TSA saw significant improvement in all clinical outcome scores at both 1 and 2 year postoperatively (Figure 10). There were baseline differences between groups such that patients who underwent inpatient TSA were more likely to be diabetic than those who underwent outpatient TSA. The authors found no significant differences in improvements in clinical outcome scores between inpatients vs. outpatient groups. They noted that complications were more frequent in patients who underwent inpatient TSA (11.4% vs. 2.1%), although this did difference did not reach statistical significance (p = 0.080). Brolin et al. evaluated 30 patients who underwent outpatient TSA at a freestanding ambulatory surgery center and compared...
them with an age- and comorbidities-matched cohort of 30 patients who underwent inpatient TSA [5]. The authors evaluated 90-day complications, hospital admissions/ readmissions and reoperations. There were significant differences between outpatient and inpatient cohorts regarding preoperative demographics. The authors reported no

Figure 10.
A 2-years follow-up X-ray for an outpatient total shoulder arthroplasty (TSA).

Figure 11.
A 2-years follow-up X-ray for an outpatient reverse total shoulder arthroplasty (RTSA).
hospital admissions from the outpatient cohort and no readmissions from the inpatient cohort. There was no difference in the complication rates between outpatient (13%) and inpatient (10%) shoulder arthroplasty.

ii. RTSA.

Erickson et al. reported the results on 241 patients (average age 68.9, 52.3% female) who underwent outpatient RTSA between 2015 and 2017 by the senior author (Figure 11). The authors matched this group of patients to a group of 373 patients who underwent RTSA as an inpatient. There were baseline differences between the two groups such that significantly more inpatient RTSA had diabetes (p = 0.007) and had a significantly higher body mass index (p = 0.022). The authors found that patients who underwent outpatient RTSA had significant improvement in all clinical outcome scores at both 1 and 2 year postoperatively (all p < 0.0001). There were no significant differences in improvements in clinical outcome scores between inpatient vs. outpatient RTSA groups. Most importantly, complication rates were significantly lower for patients who underwent RSTA as an outpatient compared to those who underwent RTSA as an inpatient (7.0% vs. 12.7% p = 0.023).

5. Conclusion

Many patients are candidates for outpatient TSA and RTSA. Some patients may be better suited to have their surgery performed in the hospital setting while other are excellent candidates for an outpatient surgical center. A thorough preoperative evaluation is critical for proper patient selection and a set protocol is necessary for the day of surgery to ensure proper pain control and to minimize risk of complications and readmissions. When performed properly, patients should expect the same outcomes as those who undergo TSA and RTSA in the inpatient setting with potentially lower complication rates.
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