An Original Study

Minimal-Incision Total Shoulder Arthroplasty: A Cadaveric Study

Jason A. Schneider, MD, J. David Hill, MD, Frances Cuomo, MD, and Peter D. McCann, MD

Abstract

Traditional exposure for total shoulder arthroplasty (TSA) is a deltopectoral incision of approximately 17 cm. Recent literature suggests that minimally invasive surgery for knee and hip arthroplasties may be successful in reducing perioperative morbidity and improving patient satisfaction. In the study reported here, we evaluated a minimal-incision approach to TSA. Using 10 fresh-frozen cadaveric shoulders, we performed TSAs through a 6-cm incision originating at the center of the coracoid process and extending distally along the deltopectoral interval. Soft-tissue releases, humeral osteotomy, and glenoid resurfacing were performed in all 10 cadaver shoulders using standard TSA retractors and guides. No skin or soft-tissue complications were observed. We conclude that it is technically possible to perform TSA through an appropriately placed minimal (6-cm) incision.

The clinical success of total shoulder arthroplasty (TSA), which is well documented, is especially dependent on surgical technique. Adequate exposure with sufficient soft-tissue releases and complete visualization of the glenohumeral articulation are critical.[1-3]

The traditional exposure for TSA is a 17-cm deltopectoral incision extending from the clavicle across the coracoid and down to the deltoid insertion.[1] Minimally invasive surgery (MIS) total knee arthroplasty (TKA) and total hip arthroplasty (THA) were developed recently and have been successful in reducing perioperative morbidity and hospitalization without compromising clinical outcomes.[4-7] MIS-TSA has not been investigated as extensively.[8,9]

This cadaveric study evaluated a minimal-incision TSA approach using a 6-cm incision originating at the coracoid process and extending distally along the deltopectoral interval. We hypothesized that sufficient exposure for surgical releases, humeral osteotomy, and glenoid resurfacing using standard TSA instrumentation and retractors could be achieved with a well-placed minimal incision.

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Materials and Methods

A Global Advantage prosthesis (DePuy, Warsaw, Ind) and a mini-incision were used to perform a TSA on each of 10 cadaver specimens (mean age, 82 years; range, 72-85 years). The incision originated at the center of the coracoid process and extended 6 cm distally along the deltopectoral interval (Figure 1) Generous subcutaneous flaps were elevated (Figure 2). The cephalic vein was mobilized laterally with the deltoid muscle. The pectoralis major tendon was identified distally but not incised. The subscapularis tendon was incised at the lesser tuberosity and then released in continuity with the underlying capsule, which was further elevated off the humeral neck inferiorly and posteriorly. The axillary nerve was identified and palpated inferiorly but not routinely exposed. The subscapularis muscle was then freed from the underlying capsule medially, and the medial capsule and labrum were excised. The humeral head was dislocated anteriorly and its diameter measured (Figure 3). Presence or absence of arthritis was noted, as was the integrity of the rotator cuff. A humeral head osteotomy was performed with a standard, flat humeral osteotomy template (Figure 4). The medullary canal was reamed and broached.

Figure 1. On a right shoulder, the 6-cm incision originates at the center of the coracoid process and extends distally along the deltopectoral interval.

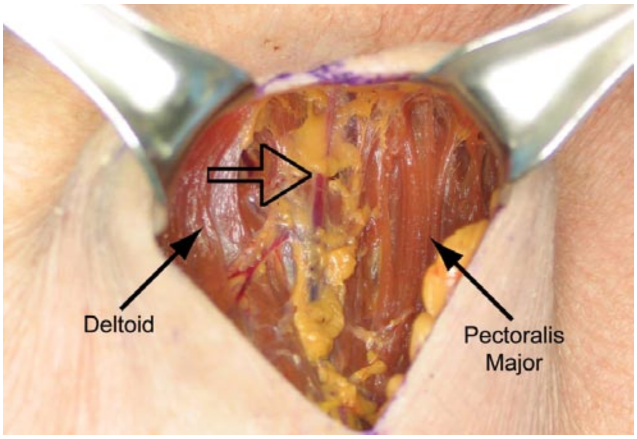

Figure 2. After skin flaps are developed, the deltopectoral interval is visualized. The cephalic vein (open arrow) is in the interval.

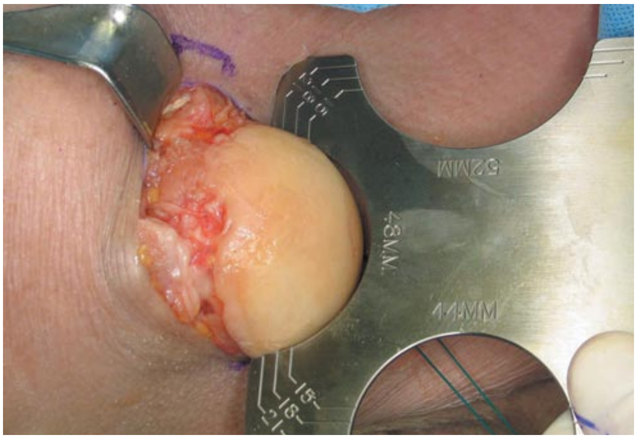

Figure 3. Delivery of the humeral head of the right shoulder. The 6-cm incision allows presentation of a 48-mm head.

Attention then shifted to the glenoid. The glenoid was exposed and measured with standard glenoid sizing disks (Figure 5) and then prepared for an anchor-peg glenoid component (Figure 6). Trial components were inserted, and stability, range of motion, and subscapularis repair were assessed.

Results

TSA was performed without difficulty through a 6-cm incision in all 10 shoulders. None of the 10 incisions had to be extended, and there was no skin damage from retractors or saw blades. No pectoralis major tenotomy was required for additional exposure. Four TSAs were performed in thin specimens; the other 6 were performed in specimens with a normal body habitus. Rotator cuff tendons were intact in 8 shoulders; the other 2 had massive cuff tears and advanced glenohumeral arthritis. Humeral heads measured 52 mm (4 shoulders), 50 mm (4 shoulders), and 44 mm (2 shoulders), for an overall mean of 50 mm. Glenoids measured 48 mm (8 shoulders) and 44 mm (2 glenoids), for an overall mean of 47 mm. All trial reductions were stable, demonstrating the desired 50% glenohumeral translation with manual testing, and all subscapularis tendons were repaired routinely to drill holes in the anterior neck of the humerus with the arm in 40° of external rotation.

Figure 4. Humeral osteotomy in a right shoulder allows adequate visualization of the humeral neck.

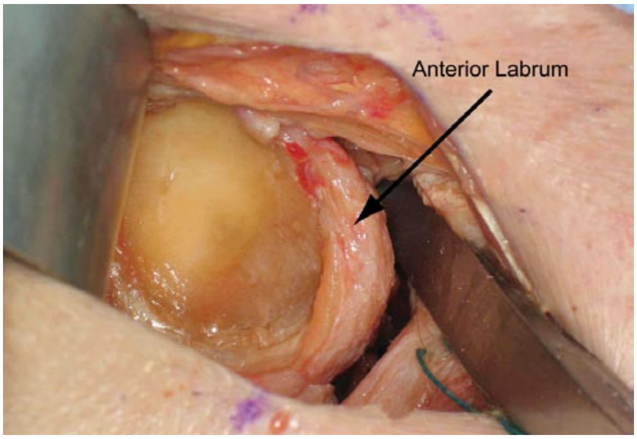

Figure 5. Adequate exposure of the glenoid fossa with standard retractors.

Discussion

The goal of TSA is to relieve pain, restore motion, and improve function. Successful results with few complications have been described in numerous reports.[2,10-17]

Recently, MIS has been used in both hip and knee arthroplasties.[6,7] The premise of MIS is to reduce perioperative morbidity without compromising the safety, efficacy, and durability of the procedure. The purported advantages of MIS-THA and MIS-TKA include shorter hospital stay,

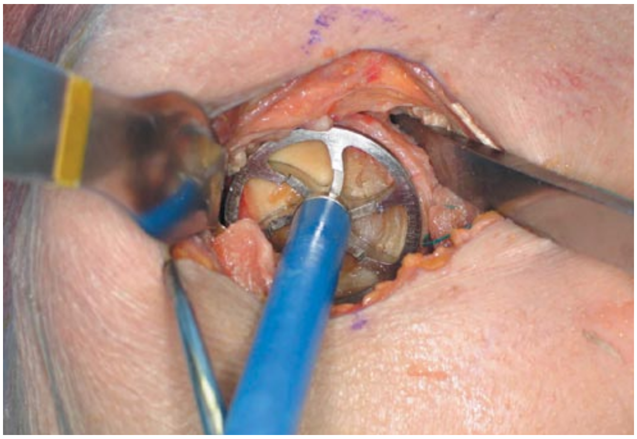

Figure 6. Sufficient exposure with circumferential visualization allows for glenoid reaming.

Figure 7. Healed minimal (6-cm) incision after right total shoulder arthroplasty in a female patient in her mid 70s.

decreased morbidity, faster rehabilitation, and improved cosmesis; the disadvantages include difficulty, specialized instrumentation requirements, and risk for component malposition resulting from limited exposure.[4-7]

No clinical studies have evaluated the efficacy of MIS-TSA. As with MIS-THA and MIS-TKA, the theoretical advantages of MIS-TSA include increased patient satisfaction owing to improved cosmesis and decreased morbidity. With regard to THA and TKA, MIS implies not only a smaller skin incision but less disruption of periarticular ligaments and tendons during joint arthroplasty. We call our approach minimal-incision and not minimally invasive because the deeper MIS approach, with its division of only the subscapularis tendon, is no different from the traditional approach, with its deep dissection and 17-cm skin incision.[1] We performed this cadaveric study to evaluate the technical efficacy of performing TSA through a 6-cm incision.

Blaine and colleagues[8] used a minimal concealed axillary approach (7 cm) or lateral coracoid approach (5 cm) for TSA. Their lateral coracoid approach is very similar to the mini-deltopectoral approach used in our study. They recommended a more lateral incision to better accommodate the standard instrumentation required for retraction and bone preparation during TSA. In our study, we found that a similar incision beginning at and not lateral to the coracoid easily accommodates standard instrumentation. Blaine and colleagues also recommended a 5-cm incision on the basis of their anatomical study, which showed a mean humeral head diameter of 49 mm, which is remarkably similar to ours (50 mm). We recommend a 6-cm incision to accommodate a possibly larger head diameter.

In our study, length and placement of the incision were based on several factors. For incision length, the most important factor is humeral head diameter. The diameter of most humeral heads is less than 60 mm, and we felt that 6 cm would be adequate for dislocation and presentation of the humeral head into the operative field for the humeral neck osteotomy. Regarding incision placement, it is important to allow proximal exposure of the superior glenoid and distal exposure sufficient for capsular releases off the humeral neck. The incision begins at the center of the coracoid and extends distally in line with the deltopectoral interval. Development of generous subcutaneous flaps allows for creation of a mobile "window" to enable both proximal and distal exposure. The usual tendency is to place the incision too laterally, thereby compromising subsequent glenoid exposure and risking deltoid denervation by inadvertent splitting of the anterior deltoid. The combination of starting the incision at the coracoid tip, extending it 6 cm within the deltopectoral interval, and developing wide subcutaneous flaps afforded adequate exposure for TSA. Furthermore, this minimal-incision TSA approach did not require specialized retractors or instrumentation for exposure, releases, or bone preparation.

We have used this minimal-incision TSA approach in several patients (smaller women with minimal deformity) and have had no difficulty with exposure or instrumentation. Patient acceptance and cosmesis have been very good (Figure 7), and outcomes at early clinical follow-up are indistinguishable from those achieved with the traditional TSA approach. Longer follow-up will be required to determine clinical benefit, but early subjective outcomes are encouraging.

One shortcoming of this study is that it was a cadaveric study performed with relatively thin specimens lacking significant deformity and soft-tissue contracture. In larger patients with the usual bony and soft-tissue pathology of glenohumeral arthritis, adequate exposure may not be possible with a 6-cm incision. Our early experience indicates that this approach is feasible in select patients. Future studies will determine the feasibility and efficacy of the minimal-incision approach described in this pilot study. Nevertheless, our findings provide anatomical information that will be useful in subsequent clinical studies designed to determine the possible benefits of minimal-incision TSA.

TSA performed through a minimal incision is technically possible. Sufficient exposure for surgical releases, humeral osteotomy, and glenoid resurfacing can be achieved with a 6-cm incision. Proper incision placement and development of generous subcutaneous flaps are critical to the success of the procedure. Future studies will determine whether this minimal-incision approach is of clinical benefit.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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