SURGICAL TECHNIQUE

A New Surgical Technique for Extensive Exposure of the Proximal Humerus and Shoulder

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Different techniques have been described for surgical exposure of the shoulder and proximal humerus. However, the neurovascular and muscular anatomy in the proximity of the humerus precludes the use of a “safe” extensive approach. We here present a new technique for extensive exposure of the proximal humerus and shoulder for wide resection of tumors. By reflecting the deltoid with its origin as an osteomyocutaneous flap downwards and backwards, the entire shoulder, including the rotator cuff and proximal humerus, are exposed with minimal damage to the blood supply and function of the deltoid muscle. This approach, which is a logical combination of anterior, transacromial and deltoid splitting approaches, was used in 17 patients, 11 achieving satisfactory functional results. Our new surgical approach reduces intraoperative damage to the blood supply of the deltoid and results in better function of the shoulder postoperatively because both the powerful intermediate muscle fibers of the deltoid and its acromial origin remain intact.

Key words: Acromion; Extensive exposure; Osteotomy; Proximal humerus

Introduction

Different surgical techniques have been described for extensive exposure of the shoulder and proximal humerus; anteromedial, anterolateral, and posterior being the classical approaches described in published reports¹. However, there are practical difficulties with the anteromedial approach in that the incision is deepened through the deltopectoral groove, which violates the basic principles of tumor surgery because it involves two compartments. Moreover, it is sometimes necessary to osteotomize the tip of the coracoid process to facilitate exposure of the deep structures of the shoulder joint. The pectoralis major may also obstruct the view unless it is detached from its insertion. In the Gardener extensile anterolateral approach, the 4 to 5 cm long avascular raphe between the anterior and middle thirds of the deltoid is defined; splitting the muscle here provides a fairly avascular approach to underlying structures. However, although this extensile anterolateral approach is very useful for plate fixation of proximal humeral fractures, damage to branches of the axillary nerve occurs even within the surgical field, limiting

this approach's usefulness for adequately exposing proximal humerus tumors^{1,2}. The transacromial approach is excellent for surgery of the musculotendinous cuff and for fracture-dislocations of the shoulder. However, limited exposure is often a problem. As is true of most anterior approaches, the neurovascular and muscular anatomy in the proximity of the humerus precludes the use of a “safe” extensive approach posteriorly³.

To overcome the main disadvantages of these incision techniques, we here describe a new surgical technique for extensive exposure of the proximal humerus and shoulder and briefly describe the seventeen patients in whom this technique was used.

Surgical Technique

With the patient supine, a sandbag is wedged under the spine and medial border of the scapula to push the affected side forward while allowing the arm to fall backward, opening up the front of the joint⁴. The exact dimensions of the tumor as assessed by preoperative diagnostic imaging and

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Fig. 1 Clinical photographs showing the distal and proximal extent of the proposed skin incision, which includes the biopsy track (red arrow).

planning are used to determine the locations of skin incisions to ensure safe margins.

The skin is incised superiorly just lateral to the acromioclavicular joint from the posterior aspect of the acromion and continued anteriorly like a shoulder strap to a point 5 cm distal to the anterior edge of the acromion, as in the transacromial approach¹. It is then extended inferiorly over the anterior third of the deltoid, avoiding the deltopectoral groove but including the biopsy track (Fig. 1). After making the skin incision, the osteotomy site on the acromion is marked with cautery. The acromion is osteotomized in a "V" shape, with an angle of

Fig. 2 Diagram showing the osteotomy site of the acromion and the site of splitting the deltoid through the avascular raphe between the anterior and middle third of the muscle (shown by red line).

Fig. 3 Intra-operative photograph showing the exposed tumor in the proximal humerus after reflection of the deltoid along with its acromial attachment distally.

about 120° (Fig. 2). If the biopsy track allows, the 4 to 5 cm long avascular raphe between the anterior and middle thirds of the deltoid is defined and the muscle split there. An osteomyocutaneous flap comprising the osteotomized acromion and the origin of the deltoid from it is reflected inferiorly and laterally to expose the entire anterior, superior, and posterior parts of the shoulder joint and proximal humerus (Fig. 3).

The surgical technique after skin incision and reflection of the osteomyocutaneous flap has previously been presented in detail⁵⁻⁸. It is important to identify and, if possible, protect the axillary nerve and posterior circumflex vessels emerging from the quadrangular space while the resected bone is being elevated from its bed (Figs 4 and 5). Finally, repair of the acromion is performed using size 5 polyester suture or surgical steel wire. The suture is passed through the trapezius muscle just medial to the intact portion of the acromion and then deep to the detached portion of the acromion to emerge through the deltoid; the ends are then tied squarely (Fig. 6).

Fig. 4 Intra-operative photograph showing the surgeon palpating the axillary nerve underneath the deltoid muscle.

Fig. 5 Intra-operative photograph showing the situation after tumor resection. The intact axillary nerve can be seen lying over the posterior surface of the deltoid muscle.

This results in anatomical restoration of the acromion and contour of the shoulder. No attempt is made to fix the fragment with screws.

Case Reports

We have used this technique in seventeen patients (seven female and ten male). Their average age at surgery was 29 years (range, 12–65 years). Eight patients had osteosarcomas, four chondrosarcomas, two giant cell tumors, two chondroblastomas of the proximal humerus and one a metastasis from thyroid cancer in the proximal humerus. The mean follow-up was 31 months (range, 10–60 months). All wounds healed well. At the last follow-up, none of the patients had any sign of infection. None of the patients had pain over the osteotomy site after 12 months.

Four patients had radiological evidence of nonunion of the acromion at the osteotomy site. Clinical examination of these patients revealed no abnormal movement of the fragments on attempted contraction of the deltoid. Four patients died of their underlying malignancy. Three patients had local recurrence requiring forequarter amputation. We assessed functional outcome by grading maximum overhead abduction as poor (less than 60°), fair (between 60°–90°) and excellent (more than 90°). Three patients had poor or fair functional results because of either prosthesis loosening or nonunion of grafted to host bone. The rest of the patients had excellent functional results.

This new surgical technique was used to treat an osteosarcoma of the proximal humerus in a 14-year-old boy by resection and tumor endoprosthetic reconstruction (Fig. 7). The wound healed uneventfully without infection. The patient had good function of the shoulder, with abduction to 120° at 30 months of follow-up.

Discussion

We here present a new surgical technique for extensive exposure of the proximal humerus and shoulder. Our

approach is especially useful for limb-saving surgical resection of proximal humeral tumors for which adequate exposure of the proximal humerus is necessary. Our new surgical approach may improve the exposure because an osteomyocutaneous flap comprising the osteotomized acromion and the origin of the deltoid is reflected inferiorly and laterally to expose the entire anterior, superior, and posterior parts of the shoulder joint and proximal humerus.

Gardner *et al.* demonstrated that the deltoid splitting approach can be extended distally by isolating the axillary nerve and posterior circumflex artery. In a cadaveric study, they identified the cordlike axillary nerve on the undersurface of deltoid by sweeping a finger laterally beneath the raphe to palpate it^{1,2}. This blind palpation technique for identifying the axillary nerve requires considerable experience, whereas osteotomizing the acromion in a V shape facilitates more reliable identification and protection of this nerve.

We would like to compare our new surgical technique to carefully peeling a banana skin to expose the underlying fruit. The middle and posterior deltoid fibers, along with the osteotomized portion of the acromion, are reflected down to expose the underlying proximal humerus and shoulder just like peeling a banana skin.

Despite our efforts to achieve anatomical reduction and stable fixation of the osteotomized acromion, some patients did develop the postoperative complication of nonunion of the acromion. The high reported rate of nonunion after traumatic acromion fractures⁹ may partially explain the incidence of this complication. In addition, we focused our efforts on adequately exposing the proximal humerus while minimizing damage to the neurovascular structures and deltoid muscle² and did not specifically focus on surgical fixation of the osteotomized acromion, thereby possibly failing to adequately stabilize the osteotomy site. However, none of our patients developed major pain or disability because of nonunion of the acromion, possibly because stable painless fibrous union occurred. Further, published reports acknowledge that

Fig. 6 Intra-operative photograph showing suturing of the acromion using polyester sutures.

Fig. 7 A 14-year-old boy with osteosarcoma of the proximal humerus (A) Preoperative radiograph (B) Intra-operative photograph showing the situation after implantation of tumor endoprosthesis (C) Postoperative radiograph showing tumor endoprosthesis after resection of proximal humeral osteosarcoma.

nonunion of the acromion does not produce significant functional disability unless the subacromial space is reduced¹⁰⁻¹².

Because proximal humeral tumors necessitate division of the deltoid muscle near its origin and sacrifice of its insertion is sometimes necessary, the deltoid muscle is always at risk of losing its blood supply partly or fully during excision of these tumors. Further, muscle to bone healing

is predictably weak, with risk of pull out later at the time of mobilization. These factors may result in non-functioning of the deltoid muscle postoperatively. Our new surgical approach reduces the severity and incidence of this complication because the powerful intermediate muscle fibers of the deltoid along with its acromial origin remain intact¹³.

References

1. Crenshaw AH, Canale ST, Beaty JH. Surgical techniques and approaches. In: Canale ST, Beaty JH, eds. *Campbell's Operative Orthopaedics*, 12 edn. St. Louis, MO: Mosby, 2012; 91-95.
2. Gardner MJ, Griffith MH, Dines JS, Briggs SM, Weiland AJ, Lorch DG. The extended anterolateral acromial approach allows minimally invasive access to the proximal humerus. *Clin Orthop Relat Res*, 2005, 434: 123-129.
3. Zlotolow DA, Catalano LW 3rd, Barron OA, Glickel SZ. Surgical exposures of the humerus. *J Am Acad Orthop Surg*, 2006, 14: 754-765.
4. Hoppenfeld S, deBoer P, Buckley R. *Surgical Exposures in Orthopaedics: the Anatomic Approach*, 4th edn. Philadelphia, PA: Lippincott Williams & Wilkins, 2009.
5. Potter BK, Adams SC, Pitcher JD Jr, Malinin TI, Temple HT. Proximal humerus reconstructions for tumors. *Clin Orthop Relat Res*, 2009, 467: 1035-1041.
6. El-Sherbiny M. Reconstruction of the proximal humerus after wide resection of tumors: comparison of three reconstructive options. *J Egypt Natl Canc Inst*, 2008, 20: 369-378.
7. Shi SF, Dong Y, Zhang CL, Bao K, Ma XJ. Prosthesis replacement of the proximal humerus after the resection of bone tumors. *Chin J Cancer*, 2010, 29: 121-124.
8. Li J, Wang Z, Guo Z, Wu Y, Chen G, Pei G. Precise resection and biological reconstruction for patients with bone sarcomas in the proximal humerus. *J Reconstr Microsurg*, 2012, 28: 419-425.
9. Meller R, Krettek C. Fractures of the lateral clavicle and acromion. *Unfallchirurg*, 2012, 115: 879-886.
10. Kuhn JE, Blasler RB, Carpenter JE. Fractures of the acromion process: a proposed classification system. *J Orthop Trauma*, 1994, 8: 6-13.
11. Mick CA, Weiland AJ. Pseudoarthrosis of a fracture of the acromion. *J Trauma*, 1983, 23: 248-249.
12. Mencke JB. VIII. The frequency and significance of injuries to the acromion process. *Ann Surg*, 1914, 59: 233-238.
13. Standring S, Borley RN, Gray H. *Gray's Anatomy: the Anatomical Basis of Clinical Practice*. Edinburgh: Churchill Livingstone/Elsevier, 2008.