



Management of Intra-articular Fractures of Distal End of Humerus Using Modification of the Triceps Aponeurosis Tongue Approach

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Received: July 22, 2015

Revised: September 24, 2015

Accepted: September 28, 2015

► ABSTRACT

Objective: To evaluate the functional outcome and extensor apparatus of operative management of intra-articular fractures of distal humerus using modification of the Triceps Tongue Flap approach.

Methods: This prospective study was conducted between June, 2012 to April, 2014 in NIMS Medical College and Hospital, Jaipur, Rajasthan (India). We included 23 patients with intra-articular fractures of distal humerus that were managed surgically. Modification of Triceps Tongue Flap approach with Triceps flap in inverted 'V' shape was used. Follow-up was done using standard radiograph anteroposterior/lateral (AP/Lat) at immediate postoperative day, 1, 3, 6 and 12 month intervals. Functional outcome was assessed using range of motion at elbow joint, Disability of Arm, Shoulder and Hand (DASH) Score and Objective Muscle Strength Testing (MRC Grade) of triceps muscle at 1, 2, 3, 6 and 12 month follow-up.

Results: Overall we included 23 patients of whom 16 (69.5%) were men and 7 (30.5%) were women with mean age of 34.6±4.8 years. Mean duration of the follow-up was 12.9±1.1 months. Mean DASH Score at final follow up was 7.7±1.1 (indicating mild residual impairment). Mean muscle strength at final follow-up was 4.7±0.4 (Range 3 to 5). Mean flexion deformity at elbow was 9.2±0.9 (Range 5 to 45) degrees and mean arc of flexion extension was 119±3.4 (Range 65 to 140) degrees.

Conclusion: This approach provides an excellent exposure as well as a good functional outcome as measured by DASH score and full range of motion at the elbow joint with return of almost complete power of the extensor apparatus in patients with intra-articular fractures of distal humerus.

Keywords: Triceps tongue flap approach; Intra-articular fractures; Distal humerus; Disability of Arm; Shoulder and Hand (DASH) Score.

Please cite this paper as:

Sharma S, Tiwari M, Chaturvedi H. Management of Intra-articular Fractures of Distal End of Humerus Using Modification of the Triceps Aponeurosis Tongue Approach. *Bull Emerg Trauma*. 2015;3(4):128-133.

Introduction

Fractures of the distal end of humerus are clinically difficult to manage intra-operatively. The preferred treatment for displaced, intra-articular,

intercondylar fractures of the distal part of the humerus is open reduction and internal fixation [1]. These type of unstable fracture patterns like displaced unicondylar, bicondylar, intra-articular need urgent open reduction and internal fixation

maintaining the normal anatomy [2]. Operative stabilization and management of fractures of distal humerus require good exposure of the fracture site and elbow joint. Posterior approach to the elbow joint is the most popular approach being used currently including triceps splitting or triceps reflecting. Olecranon osteotomy is yet another popular approach for distal humerus articular fractures [3-5]. Olecranon osteotomies are commonly used for the approach to intra-articular distal humerus fractures but they are often associated with procedure related complications or complaints. The drawbacks associated with olecranon osteotomy and other extensor mechanisms are malunion, nonunion, slipping of hardware. Total elbow arthroplasty cannot be performed in such cases as it requires olecranon to be intact for the fixation of the implant.

The approaches discussed above like triceps splitting and reflecting though are very popular and commonly used but have a limit to the exposure as compared to olecranon osteotomy which has its own pros and cons. Many new approaches and their modifications have been developed for better visualization of the fracture geometry. Popular distal end humerus approaches used these days are triceps dividing TRAP (Triceps Anconeus Pedicle) and Von Gorder Approach. To avoid complications associated with olecranon osteotomy and to overcome limitation of inadequate exposure without osteotomy, we developed modification of Triceps tongue approach.

The triceps splitting approach described by Campbell involves a midline split through the triceps tendon [6]. The triceps splitting approach has advantages like its operative ease and indications from open reduction and internal fixation to total elbow arthroplasty. Some of the disadvantages related to this approach are limited exposure, triceps weakening, impaired triceps extensor functioning.

This Modified Triceps tongue incision was a longitudinal skin incision at posterior aspect of elbow. This technique prevents the osteotomy of the olecranon and raises the triceps flap from distal part of humerus. This approach preserves neurovascular supply of anconeus, which is a dynamic stabilizer of the elbow [7]. The aim of the current study is to evaluate the functional outcome and extensor apparatus of operative management of intra-articular fractures of distal humerus using modification of the Triceps Tongue Flap approach.

Materials and Methods

Study Population

This study was a prospective study including trauma patients admitted to the department of Orthopedics in NIMS Medical College hospital affiliated with NIMS University, Rajasthan during a 22-month period from June, 2012 to April 2014. We included 23 adult patients (>18 years) with intra-articular fractures of distal humerus admitted to our

center during the study period. The inclusion criteria included closed fractures, intra articular fractures and skeletally mature patients. Those with post-traumatic neurovascular injury and extra-articular fractures were excluded from the study. Patients were evaluated radiographically using orthogonal radiography of the elbow joint. For intra-articular distal humerus fractures, a helical CT-Scan was done with 3 dimensional reconstruction to delineate the fracture anatomy.

Surgical Technique

Modification of the classical Von gorder approach (Triceps tongue) with Triceps Flap in inverted "V" shape manner was used. Patients underwent operation theatre table in lateral decubitus position under general anesthesia. Tourniquet was applied at pressure 220 to 260 mmHg. A curvilinear incision around 12-13 cm was made, about 6-7 cm proximal to elbow joint and 7-8 cm distal to elbow over ulnar border. The skin incision was curved laterally at the olecranon tip. Superficial fascia was incised followed by deep dissection and muscle reached (Figure 1).

The ulnar nerve was identified behind the medial humeral epicondyle. The ulnar nerve was then cautiously followed and isolated from soft tissue and secured away from the working area. A Triceps muscle was split via a tongue shaped incision approximately 1 cm proximal to its distal attachment at the tip of olecranon over the triceps aponeurosis. This tongue shaped triceps flap is reverse of the classical triceps tongue described by Von Gorder approach which involves the division of triceps tendon at musculotendinous junction in a "V" or "Y" shape. This tongue shaped triceps flap was elevated distal to proximal thereby exposing the fracture site with help of subperiosteal blunt and sharp dissection.

The fracture was reduced with the help of reduction clamps and the reduction was held in place with the help of 2 kirschner wires of 2.5 mm each inserted from lateral and medial epicondyle. The articular congruity was confirmed post reduction and then fixation was done using 3.5 mm Limited contact dynamic compression plate LCDCP/Reconstruction plates. Both the plates were pre-contoured before final fixation over the involved columns. Both the columns were stabilized by 3.5 mm reconstruction plates applied on the dorsal surface of humerus. Further stability was achieved with the help of 4.0 mm partially threaded cancellous screws fixed at medial or lateral epicondyles of humerus. Final reduction was confirmed under image intensifier. Range of motion at elbow was checked post-fixation of the fracture to check the stability at the joint. The triceps was repaired with interrupted number-2 absorbable sutures. A negative suction drain of size 10 or 12 was placed in situ and closure was done in layers. Sterile dressing was done and a slab was given above elbow in neutral position. Immediate postoperative radiography was

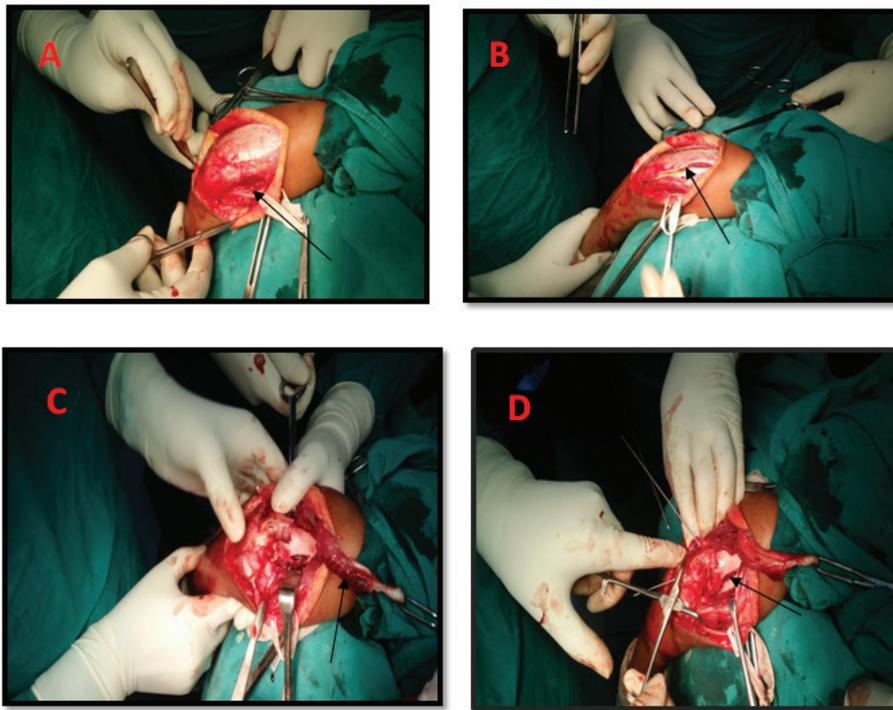


Fig. 1: **A:** Skin incision and superficial dissection with isolation of ulnar nerve (black arrow); **B:** Inverted “V” shaped triceps tongue incision (black arrow); **C:** Intra-articular fracture distal humerus with triceps belly reflected (black arrow); **D:** Intra-articular fracture of distal humerus fixed with kirshner wires(black arrow).

taken of the elbow joint in anteroposterior and lateral views (Figure 2). Range of motion exercises were started after 3 weeks in a gentle manner under the supervision of physiotherapist. Patients were not allowed for the active extension at the elbow joint post operatively to avoid any stress over the fixation until 6 weeks minimum depending on the fracture pattern and its healing.

Assessment and Follow-up

The patients were assessed clinically for any visible deformity, any neurological deficit, and range of motion at the elbow joint using the normal elbow as a control. Follow-up was performed using standard radiograph (AP/Lat) of the elbow joint at immediate postoperative, 1, 3, 6 and 12 months interval. Functional outcome was assessed using



Fig. 2. **A and B:** Computed tomography images with 3D reconstruction of distal humerus fracture (intra articular); **C:** Plain Preoperative radiography, AP, Lat views; **D:** Postoperative radiography of AP and Lat views.

DASH (Disability Of Arm, Shoulder And Hand) Score, evaluation of extensor apparatus at elbow which included objective muscle strength testing of triceps muscle, range of motion at elbow joint, and evaluation of any extensor lag.

Statistical Analysis

All the data was registered in a compute based database and were further analyzed by Statistical Package for Social Sciences (SPSS Inc., Chicago, USA). Data are presented as mean \pm SD and proportions as appropriate.

Results

Clinical Outcome

Overall we included 23 patients of whom 16 (69.5%) were men and 7 (30.5%) were women. Mean age of patients was 34.6 ± 4.8 (ranging from 23 to 56) years. Mean duration of follow-up was 12.9 ± 1.1 months. Mean DASH Score at final follow up was 7.7 ± 1.1 months (indicating mild residual impairment) at final follow up. Mean muscle strength at final follow up was 4.7 ± 0.4 (Range 3 to 5). Mean flexion deformity at elbow was 9.2 ± 0.9 (ranging from 5 to 25) degrees and mean arc of flexion extension was 119 ± 3.4 (ranging from 65 to 140) degrees. None of the patients had elbow instability during follow-up visits. Range of motion improved in the first six months (Figure 3).

Radiographic Analysis

Callus formation was clearly visible at the fracture sites as seen on anteroposterior and lateral views of elbow joints. None of the patient showed any sign of nonunion. Mean healing duration of fracture was

3.6 ± 1.6 months. Maximum malunion was 12 degrees in flexion-extension or rotation. None of the patients had loss of reduction or fixation.

Complications

None of the patients demonstrated signs of superficial or deep infection or any gaping of the sutured wound margins. One patient complained of serous discharge from the site which resolved gradually with antibiotics. No sign of any neurological deficit such as radial or ulnar nerve palsy were observed.

Discussion

There are many approaches to explore distal end humerus like anterior approach called Henry's approach, the lateral approach called Kocher's approach, and posterior approach. The anterior approach to the elbow is rarely used for the internal fixation of adult distal humerus fractures [8,9] because it provides little access to the medial and lateral columns for the application of internal fixation. Close proximity to the neurovascular structures and inadequate exposure are some of the drawbacks for this anterior approach. The Kocher approach involves identification of the interval between extensor carpi ulnaris (ECU) and anconeus [10]. This lateral Kocher's approach limits the exposure of the medial column. Posterior approaches used most commonly are olecranon osteotomy, triceps splitting (Campbell), triceps dividing (TRAP, Van Gorder), triceps sparing. Each approach has its own indications and contra indications. Surgeon's preference is one of the important factors for the



Fig. 3. Range of motion at elbow joint; **A:** Flexion at 6 weeks; **B:** Extension at 6 weeks; **C:** Flexion at final follow-up; **D:** Extension at final follow-up.

uptaking of the surgical approach. In our case series of 23 patients with distal humerus fractures we have used open reduction and internal fixation as the mode of management. We have used an approach in which we approach the distal arm (humerus) posteriorly. In our technique we have given a curvilinear incision at posterior aspect of elbow joint. The triceps muscle is incised in inverted 'V' shape, approximately 1 cm proximal to the olecranon at its distal end. Flap of the triceps is raised distal to proximal. In our technique, the anconeus muscle is not manipulated thereby the dynamic posterolateral stability of the elbow joint is maintained. The triceps sparing, or triceps-on approach used for the pediatric elbow fractures involved creating of a window along triceps muscle and sparing of the attachment of triceps on the olecranon and avoiding of olecranon osteotomy. The triceps dividing approaches like Triceps reflecting anconeus pedicle (TRAP) approach and Van Gorder approach were amongst other popular approaches. In these approaches the entire triceps anconeus pedicle flap is reflected proximally releasing the triceps muscle from distal humerus [11]. The main drawback of this approach is triceps dehiscence and extensor weakness. Another triceps dividing approach used is the Triceps Tongue approach, popularly known as Van gorder approach in which the triceps tendon is divided at its musculo-tendinous junction. In this technique ,the transaction of the triceps is done in form of "V". This approach also carries the same risks and complications as described for TRAP approach.

Campbell described yet another approach for distal humerus open fractures in which midline incision was given at the triceps through triceps tendon [12]. Partial excision of olecranon tip was done for better visualization [13]. Limited visibility, triceps dehiscence, extensor mechanism dehiscence were some of the drawbacks of this approach [14]. When compared with other posterior approaches, osteotomy of the olecranon provides the best visualization of the distal humerus articular surface [12], which is its main advantage. The main disadvantages of the approach are the complications associated with an osteotomy, including nonunion, malunion, and hardware irritation [11]. Fixation of the olecranon osteotomy can be achieved with tension band wiring [13], screw/tension band constructs, or compression plating [14]. Various complications have been reported by many authors associated with tension band wiring of olecranon [15-17]. In a study of 88

fractures of the olecranon, Horne *et al.* reported that 66 (75%) patients required removal of the wire within one year because of pain and 7% patients had nonunion [5]. Ring *et al.* reported a non-union rate of 30% of transverse olecranon osteotomy in surgical fixation of fractures of distal humerus [5]. Triceps-reflecting anconeus pedicle approach can avoid such problems altogether.

Olecranon osteotomy provides better operational exposure than triceps splitting approach. However this exposure was not better than the triceps reflecting approach [18]. The end range of motion allows better visualization of the site to be fixed. Askew *et al.* reported loss of strength of triceps in all patients with olecranon osteotomy or triceps-splitting approach [5]. The Modified Triceps tongue approach provides adequate exposure of the distal part of humerus there by allowing good reduction and outcomes in complex intra articulate fractures as well. The reduction of the fracture and stable fixation can be performed without performing osteotomy of the olecranon [13]. The operative fixation performed in our cases were having fixation, stable enough for postoperative rehabilitation. Our main concern was avoidance of postoperative extensor apparatus [19,20] dysfunction, none of the cases operated in our study resulted into any dysfunction at elbow or any other mechanical or neurological deficit, while providing excellent exposure intraoperatively. Ulnar nerve as protected by the medial part of triceps that reduces the possibility of damage to its blood supply and it can glide and slide in its original position by the end are available for the repair thereby allowing satisfactory balancing of the medial and lateral sides of the elbow joint and reducing the risk of postoperative instability of the joint. There are a few shortcomings like short sample size and short follow up of our study. Operated cases may suffer from post-traumatic arthritis at elbow which develops with time. Hence, longer follow-up will be required.

In conclusion, this modification of the Triceps tongue approach provides an excellent exposure as well as a good functional outcome as quantified by DASH Score without any dysfunction of extensor apparatus of elbow. Short duration of follow up and relatively small sample size is the limitation of this study. A further study with larger sample size and longer follow up will be required to provide proper guidelines.

Conflict of Interest: None declared.

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