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A standardized chevron osteotomy for exposure of the distal humerus: a technique description and literature review

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A R T I C L E I N F O

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Level of evidence: Technical Note

Distal humerus fractures are uncommon fractures but account for nearly 7% of all emergency department visits for upper extremity fractures.[9] In addition, distal humerus fractures are the second most costly closed fracture in the upper extremity, only behind scapular fractures.[9] These frequently complex fractures may necessitate open reduction and internal fixation (ORIF) for anatomic reduction.

Multiple approaches such as triceps-splitting, triceps-reflecting/lifting, and the olecranon osteotomy have been described to provide adequate exposure to allow for appropriate instrumentation and reduction. A triceps-splitting approach, in which the triceps is incised in the midline down to the olecranon, may not provide the amount of exposure necessary due to inherent soft tissue constraints. A triceps-reflecting approach may result in delayed healing due to the disruption of the native insertion of the triceps tendon onto the olecranon and frequently requires reflection of surrounding structures such as the anconeus or forearm fascia.[7,10] The olecranon osteotomy provides ample exposure while maintaining a simple surgical technique and adequate bony healing when compared to the aforementioned exposures.[13,15] Although reliable, there is little standardization and reproducibility of the technique for creation of a transverse or chevron olecranon osteotomy.

We present a surgical technique for a standardized chevron osteotomy of the olecranon for exposure of the distal humerus utilizing a novel cutting guide and precontoured fixation plate.

This technique allows for adequate exposure while enhancing the subsequent fixation of the osteotomy site. We also provide a literature review of the outcomes and complications of the chevron osteotomy.

Anatomy

The olecranon is the posterior-most aspect of the proximal ulna and serves as the insertion of the triceps tendon. On the anterior surface, the olecranon is comprised of the trochlear notch superiorly and the coronoid process and radial notch inferiorly, all of which are covered with articular cartilage. At the junction of the two, there is a well-described "bare area" where there is no articular cartilage. Ting et al[14] reported that the location of the central bare area was consistently approximately 5 mm distal to the deepest portion of the trochlear notch and approximately 23 mm distal to the tip of the olecranon. The location of an olecranon osteotomy, regardless of technique, should aim at this bare area as to not unnecessarily disrupt the articular surface.

Indications/contraindications

An olecranon osteotomy is suitable for all intra-articular distal humerus fractures that necessitate maximum exposure to achieve

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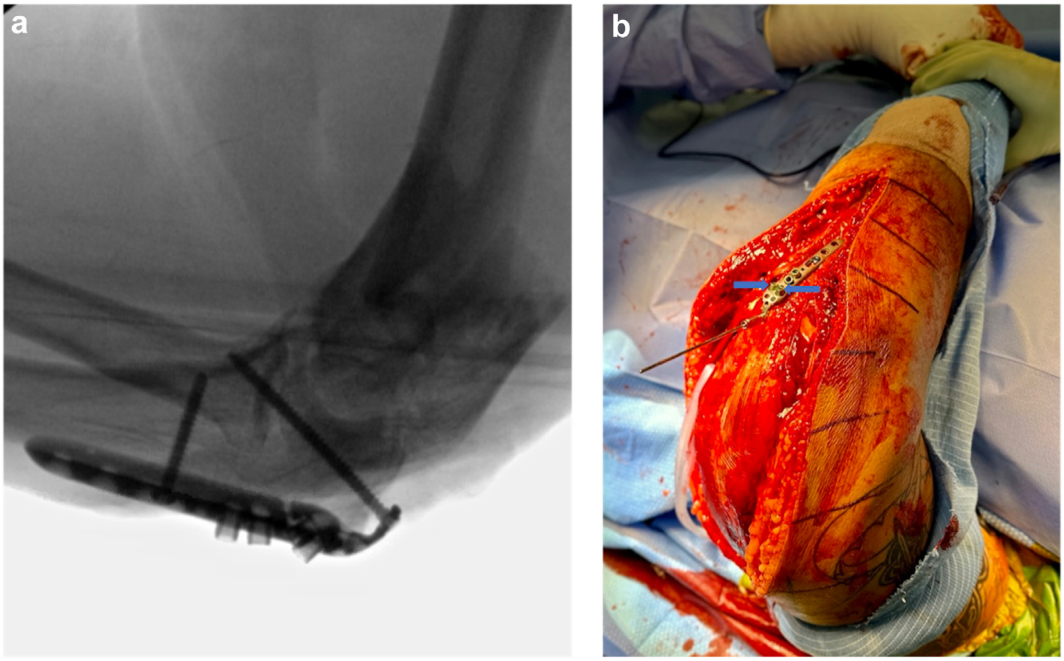

Figure 1 Lateral intraoperative fluoroscopy (**a**) and clinical photograph (**b**) of the elbow demonstrating provisional fixation of the proximal-ulna plate prior to creation of the osteotomy. The proximal parallel drill-holes are where the subsequent cutting guide will align proximally (*arrows*).

adequate instrumentation and anatomic reduction. It can also be used for complex distal third humerus fractures that have not propagated to the articular surface and repair of mal- and non-unions. Case-specific considerations which may lead to a different choice in exposure may include open fractures, soft-tissue injuries, or certain fracture patterns.

Surgical technique

The patient is positioned either supine with the affected arm across the body or lateral decubitus with the affected arm resting on an arm bump. A midline posterior approach to the elbow is utilized with medial and lateral subcutaneous flaps to ensure enough exposure to visualize the entire triceps. The deep fascia is then incised, the ulnar nerve is identified, carefully dissected, and released.

With the olecranon adequately exposed, a 5-mm stab incision is made midline and parallel to the triceps tendon fibers just proximal to the tip of the olecranon in an inverted "T" fashion. This stab incision is to ensure that the precontoured proximal ulna plate is seated down to the bone surface. The olecranon should be assessed for osteophytes, and contouring of the olecranon can be done with a rongeur if necessary. Once the precontoured plate is appropriately positioned with the proximal-most hole, colloquially termed the "home-run" tab, seated within the stab incision of the triceps tendon, a bicortical drill hole is made in the center of the ulna shaft oblong hole. The depth gauge is used to measure and the appropriately sized screw is placed. This screw hole will also later serve as a fixation point for the chevron osteotomy cutting guide. The subsequent hole is drilled at the "home-run" tab in a distal and volar trajectory. Again, a depth gauge is used to measure, and the appropriately sized screw is placed (Fig. 1). With the plate now firmly secured to the ulna, two bicortical drill holes are made in the parallel holes at the posterior and proximal portion of the plate, following the trajectory of the provided drill guides. At this point, all screws and the plate can be removed from the ulna.

The chevron osteotomy cutting guide is now placed on the proximal ulna with the flat, proximal edge of the guide bisecting the two predrilled parallel holes, which can be marked with a marking pen for easier visualization of the hole locations. The guide is secured to the ulna utilizing the oblong hole of the guide to match the predrilled ulna shaft screw that was previously placed in the oblong hole of the plate. The guide is further secured utilizing a 2.0-Kirschner wire (K-wire) in either the proximal or distal guide wire hole (Fig. 2). If feasible, the trajectory of the subsequent osteotomy can be checked to ensure that it will occur in the bare area and not into the underlying articular cartilage. As previously mentioned, the bare area is at a mean of 5 mm distal to the deepest part of the trochlear and 23 mm distal to the tip of the olecranon.[14] The chevron osteotomy can now be performed with a small, oscillating saw, taking care not to complete the cut bicortically and damage the remaining intact articular surface. The screw, K-wire, and guide are then removed and the remainder of the osteotomy can be completed by hand with an osteotome.

After complete fixation of the distal humerus fracture, a K-wire is placed through the predrilled hole in the proximal osteotomy fragment to facilitate reduction to the ulna shaft. Once appropriately aligned, the precontoured ulna plate is placed over the K-wire and fully seated down to bone. The previously measured screw can now be placed into the oblong hole of the plate into the ulna shaft and inserted until a finger-tight endpoint. The K-wire is then removed, and the "home-run" tab is then over drilled to the osteotomy line to allow for lag compression by technique across the osteotomy. After the screw is placed in the "home-run" tab, the shaft screw can be tightened fully by hand and the rest of the screw holes can be filled for maximal fixation. Final antero-posterior and lateral radiographs or fluoroscopy should be taken to ensure appropriate screw length and position (Fig. 3). Closure should be completed in layers, if possible, with maximal coverage of the hardware to decrease the risk of prominence (Fig. 4). The ulnar nerve can be further managed as the surgeon sees fit.

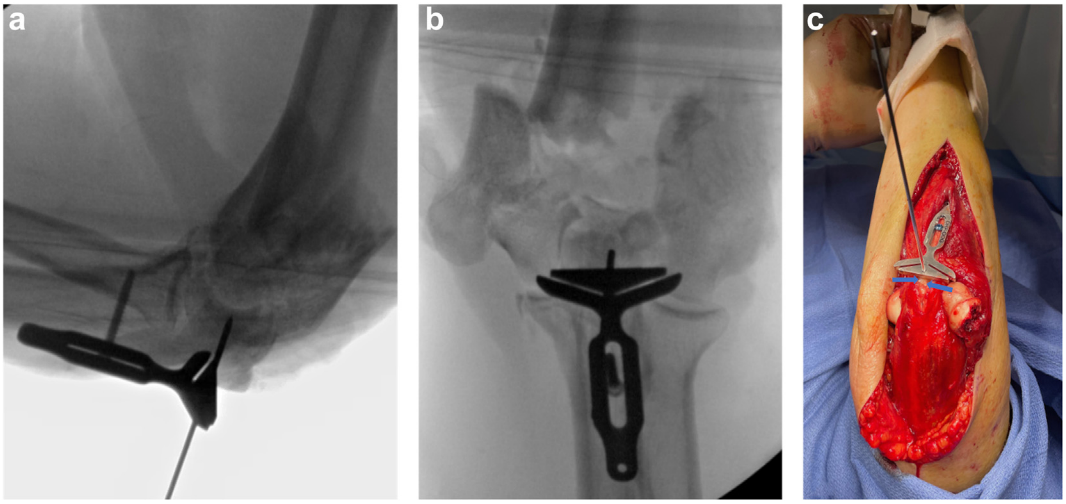

Figure 2 Lateral (**a**) and posteroanterior (**b**) intraoperative fluoroscopy and clinical photograph (**c**) of the elbow demonstrating positioning and fixation of the novel chevron-osteotomy cutting guide, with the proximal-flat surface of the guide abutting the predrilled parallel-holes (*arrows*).

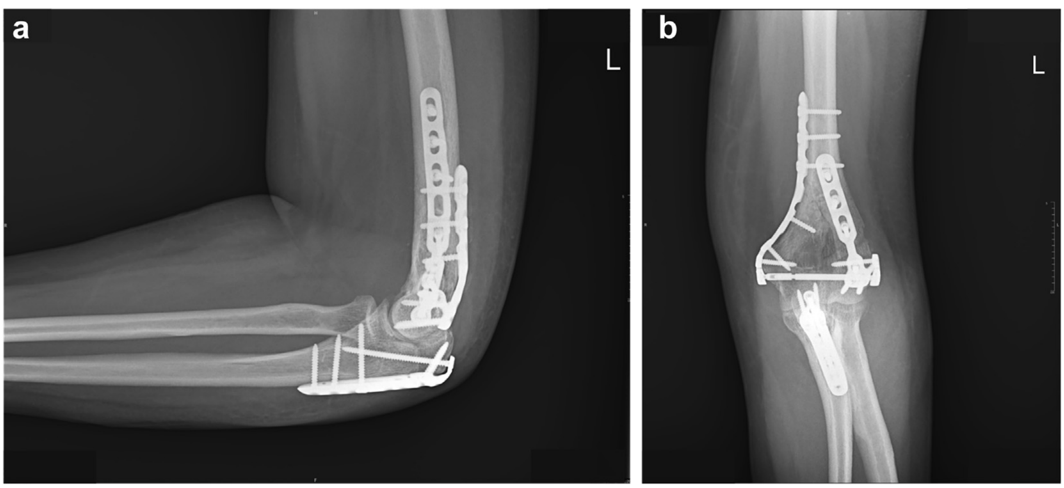

Figure 3 Lateral (**a**) and anteroposterior (**b**) radiographs of the left-elbow at 3-week status post–open-reduction and internal-fixation of a distal-humerus fracture.

Surgical outcomes and complications

The olecranon osteotomy provides ample exposure to the distal humerus to allow for anatomic reduction of intra-articular and complex fractures. This technique reduces the risk of mal- and nonunions of the osteotomy site by utilizing Arbeitsgemeinschaft für Osteosynthesefragen principles of compression plating and inter-fragmentary compression. There is also minimal additional soft tissue dissection necessary when compared to nonosteotomy exposures such as a paratricipital approach. Multiple studies[8,11] have demonstrated that there is no difference in postoperative outcomes between patients treated with olecranon osteotomies for distal humerus fractures vs. those treated without one.

Literature review

The comparison of surgical and fixation techniques of olecranon osteotomies is well reported in the literature. Criticisms of utilizing an olecranon osteotomy commonly focus on the disruption of intact bone and the belief that adequate exposure can be achieved with minimal mobilization of the triceps. Xue et al[15] reported the olecranon osteotomy resulted in satisfactory clinical outcomes and reduced operative time and bleeding when compared to the Bryan–Morrey triceps reflecting approach. Chen et al[2] demonstrated that ORIF of distal humerus fractures utilizing a triceps-sparing approach resulted in inferior outcomes when compared to those treated with olecranon osteotomy in patients greater than 60 years of age. The triceps-sparing approach reflects the triceps mechanism from medial to lateral in continuity with the forearm fascia and ulnar periosteum, resulting in extensive reconstruction of the triceps mechanism and need for protected rehabilitation postoperatively.[2] Elmadag et al[4] reported inferior Mayo Elbow Performance Score and flexion–extension motion arc with a triceps-lifting/reflecting approach when compared to olecranon osteotomy. Feinstein et al[5] compared chevron to transverse osteotomies while also comparing fixation techniques. A transverse osteotomy is made perpendicular to the long axis of the ulna and does not allow for the interdigitation of the fragments that the chevron shape provides. The authors reported higher rates of delayed and nonunions in the transverse osteotomy groups regardless of fixation technique. They also noted that chevron osteotomies had lower overall rates of complications. It has been proposed that the chevron shape provides more rotational stability

Figure 4 Clinical photograph of the elbow demonstrating closure of the deep fascia over the precontoured proximal-ulna plate.

and greater bony contact to allow for compression and healing.[5] Schmidt-Horlohe et al[12] reported a hardware removal rate of 6.4% in patients that received a chevron olecranon osteotomy with subsequent one-third tubular plate fixation during ORIF for distal humerus fractures. Heifner et al[6] reported only 1 case of nonunion in their series of 36 patients with distal humerus fractures treated with chevron osteotomy made with a standardized cutting guide and subsequently fixed with a precontoured proximal ulna plate. Similarly, Coles et al[3] reported zero nonunions in 67 patients that received chevron osteotomies with fixation by a predrilled proximal-perpendicular compression screw. The authors also suggested that cannulated screw fixation may result in greater displacement at the osteotomy site when compared to plate-and-screw fixation. In contrast, recent evidence reported by Batihan et al[1] showed that headless compression screw fixation had similar osteotomy displacement when compared to plate fixation and tension-band fixation. In totality, the recent literature contains numerous comparative studies of chevron ostectomies, and recent innovation has improved subsequent fixation techniques. Although osteotomy cutting guides may be utilized in the correction of lower-limb deformities and malalignments—such as a high tibial osteotomy—or in the upper extremity during ulnar shaft-shortening osteotomies, this is the first product we are aware of specifically for the olecranon osteotomy. Therefore, other than the aforementioned Heifner et al[6] study, there are no other peer-reviewed literature demonstrating the specific outcomes after utilization of this guide.

Conclusion

We present a surgical technique for a standardized chevron osteotomy of the olecranon for exposure of the distal humerus utilizing a novel cutting guide and precontoured fixation plate. In our experience, the technique is highly reproducible and provides adequate exposure while also providing rigid subsequent fixation of the osteotomy site.

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Conflicts of interest: Scott M. Sandilands discloses speaker's bureau relationship with Skeletal Dynamics. Edgar T. Araiza discloses speaker's bureau relationship with Skeletal Dynamics. Nathan A. Hoekzema discloses speaker's bureau relationship with Skeletal Dynamics. The other authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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