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Effect of trochleocapitellar index on adult patient-reported outcomes after noncomminuted intra-articular distal humeral fractures

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Background: Anatomic surgical reduction of intra-articular fractures of the distal humerus is important to achieve the best long-term outcomes and prevent post-traumatic arthritis. In this study we compared the radiographic reduction using the trochleocapitellar index. We also correlated the trochleocapitellar index to the functional outcomes next to the comparison of the triceps brachii lifting approach and olecranon osteotomy approach, 2 common approaches for distal humeral fractures.

Methods: From January 2006 to June 2016, patients with elbow fractures were registered in 4 centers. The trochleocapitellar index, a ratio between the angle of the capitellum and the trochlea to the midline of the distal humerus on anterior-posterior radiographs, was calculated for included patients. Functional outcomes were measured using the Oxford Elbow Score and the Mayo Elbow Performance Score. Bone healing was measured using radiographic union scoring.

Results: There were 86 patients enrolled: 46 in the olecranon osteotomy group and 40 in the triceps lifting group. Functional outcomes and bone healing did not differ between the approaches. Functional results had a medium correlation with the trochleocapitellar index, which did not differ between the 2 approaches (olecranon osteotomy group, $\kappa = 0.56$; triceps lifting group, $\kappa = 0.57$; $P = .7932$).

Conclusions: The trochleocapitellar index has a moderate predictive value on the functional results after 12 months after open reduction and internal fixation of intra-articular distal humeral factures. There is no difference in reduction, as measured by trochlear index and functional outcome scores, between the olecranon osteotomy approach and the triceps brachii lifting approach groups.

The Institutional Review Board granted ethical approval of this study.

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Anatomic surgical reduction of intra-articular fractures of the distal humerus is important to achieve the best long-term outcomes and prevent post-traumatic arthritis.[1] Incorrect reduction of an extra-articular distal humeral fracture can lead to malalignment (eg, cubitus varus or valgus) or malrotation, or both.[1] Fractures with an intra-articular involvement may lead to secondary osteoarthritis of the elbow joint[6]; therefore, anatomic reduction is paramount to minimize these secondary problems. Successful management of distal humeral fractures depends on correct reduction of the fracture, reconstruction of the articular surface if needed, a stable and rigid fixation, and appropriate rehabilitation.[1] The choice of a correct surgical approach is important to facilitate an anatomic reduction and optimal outcome.[1,13,15]

Postoperative radiographs are used to evaluate the reduction of fracture elements and the position of the fixation material.[7] Comparison to the contralateral side, especially in children, can be useful to assess the reduction. The trochleocapitellar index (TCI) might be a useful tool to assess the reduction.[10,11] However, no clinical data have been published on the value of the TCI in adults and the possible effects on functional outcomes after surgery.

This study compared the radiographic reduction and alignment after surgery using the TCI. We also correlated the TCI to the functional outcomes of the triceps brachii lifting approach (TLA) compared with the olecranon osteotomy approach (OOA), 2 commonly used approaches for distal humeral fractures.

Materials and methods

From January 2006 to June 2016, patients with elbow fractures were registered in 4 elbow Level I trauma centers: Vito Fazzi Hospital, Lecce, Italy; Elbow Unit of Rizzoli Orthopedic Institute, Bologna, Italy; Santa Maria della Misericordia, Perugia, Italy; and Upper Limb Unit, Department of Orthopedic Surgery, Amphia Hospital, Breda, The Netherlands. From these fractures, we included patients with distal humeral fractures for this retrospective comparative case study after using the following exclusion criteria: polytrauma, shaft extension of comminution, previous upper limb trauma, bilateral elbow injuries, nerve injuries, vascular injuries, extra-articular fracture type, partially articular fracture type, age younger than 18 years or older than 60 years, hematologic or oncologic pathology, bone metabolism disease, elbow osteoarthritis, and rheumatoid disease.

All fractures were classified according to the AO (Arbeitsgemeinschaft für Osteosynthesefragen) classification for distal humeral fractures.[18] The enrolled patients were divided in 2 groups by the approach used according the surgeon's preference: the OOA and the TLA. All patients were informed in a clear and comprehensive way of the type of treatment and other possible surgical and conservative alternatives. Patients were treated according to the Declaration of Helsinki ethical standards and read, understood, and signed the informed consent form.

The TCI was calculated using the method described by Gorelick et al.[10,11] The humeral shaft axis is drawn on an anterior-posterior radiograph with the humerus perpendicular to the x-ray bundle. The angle of the distal edge of the medial epicondyle is divided by the angle of the distal edge of the capitellum. This is shown in Fig. 1 for 2 patients.

The OOA was performed using a V-shaped chevron osteotomy of the olecranon converging towards distal, after a posterior incision and dissection up to the proximal ulna with protection of the ulnar nerve. This approach provides a wide exposure of the articular surface of the distal humerus, facilitating reduction and internal fixation of complex intra-articular fractures. The fixation was performed with 2 plates and screws in orthogonal or parallel configuration. All olecranon osteotomies were fixated using olecranon plates.

The TLA entailed a posterior incision, dissection up to the triceps brachii, and exposure and protection of the ulnar nerve. The triceps muscle was detached off the proximal ulna in a V-shape pointing distally and lifted. We then split the muscle from distal to proximal, enabling a view of the articular surface. Fixation was performed with 2 plates and screws in orthogonal or parallel configuration. The triceps was reattached at its insertion with transosseous Monocryl (Ethicon, Somerville, NJ, USA) sutures to minimize local reaction on the sutures.

Both groups underwent the same rehabilitation protocol (see "Rehabilitation protocol" in the Supplementary Appendix). To study the bone healing on radiographs, we used the Non-Union Scoring System (NUSS) in retrospective mode.[3] We measured bone union using the radiographic union score as described by Whelan et al.[19] The criteria to evaluate the 2 groups during the follow-up were the duration of surgery, objective quality of life, and the elbow function measured by the Mayo Elbow Performance Score (MEPS), the subjective quality of life, and the elbow function measured by Oxford Elbow Score (OES). The elbow alignment was measured using the TCI as described by Gorelick et al.[10,11] This is a ratio between the angle of the capitellum and the trochlea to the midline of the distal humerus on anterior-posterior radiographs of the elbow. The evaluation end point was 12 months after surgery.

Statistical analysis

Descriptive statistics summarized the characteristics of the study group and subgroups, including means and standard deviations of all continuous variables. We used the *t* test to compare continuous outcomes and the χ^2 test (subgroups of ≥10 patients) or the Fisher exact test (subgroups of <10 patients) to compare categoric variables. The statistical significance was defined as $P < .05$. We used the Pearson correlation coefficient (r) to compare the predictive score of outcomes and quality of life. Mean age of patients was rounded at the