

Outcomes of French's Corrective Osteotomy of the Humerus for Cubitus Varus Deformity in Children

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ABSTRACT: **Background:** Supracondylar humerus fractures are the most common elbow fractures in the pediatric population.

Objectives: To evaluate the outcomes of French's corrective osteotomy for correction of post-traumatic cubitus varus deformity in children.

Method: We conducted a retrospective review of medical charts of all patients who had undergone French's corrective osteotomy in our institution from 1998 to 2012. We recorded range of motion, cosmetic deformity, carrying angle, lateral cortex prominence index, hyperextension, and lateral cortex step before and after the surgery.

Results: Seven patients were enrolled the study. Average follow-up time was 4.6 years (range 2–9 years). An average of 18.3° of limited flexion (range 5°–35°) compared to the healthy elbow was recorded in three patients. Lateral condylar prominence was recorded in one patient. The average preoperative carrying angle was -20.5° (range -15°–30°) and postoperative angle was 9.6° (range 7°–13°). In comparison, the average carrying angle in the healthy elbow was 8.5° (range 4°–13°). No lateral cortex prominence was recorded. An average of 27.5° (range 15°–35°) of hyperextension of the distal fragment was recorded immediately postoperatively in four patients; however, during postoperative follow-up, the hyperextension was corrected spontaneously in all patients.

Conclusions: As described by French, osteotomy has the ability to correct the varus deformity only in the coronal plane. However, our research supports the assumption that hyperextension in the sagittal plane might be corrected spontaneously.

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KEY WORDS: cubitus varus, French technique, humerus, osteotomy

Supracondylar humerus fractures are the most common elbow fractures in the pediatric population [1]. Type I fractures are managed non-surgically, but most displaced injuries (types II, III, and IV) require surgical intervention. Closed reduction and percutaneous pinning remain the mainstay of surgical management. In those few cases in which reduction is less than optimal, or when a good reduction is performed but subsequently lost between follow-up visits, deformities of the distal humerus can

develop [2]. Nonunion of the lateral humeral condyle, cubitus varus, and cubitus valgus, as well as fishtail deformity as a result of avascular necrosis of the trochlea, and pseudarthrosis of the radial condyle, are the common complications of supracondylar fractures in the pediatric population [2]. Cubitus varus is the most common late complication of a supracondylar fracture of the humerus in children [1,2]. It usually results from malunion with medial displacement, internal rotation, and hyperextension of the distal fragment, which eventually heals in a varus position [3,4]. In the past, the common assumption was that the major problem was cosmetic rather than functional [5-7]. However, some studies show complications of a cubitus varus deformity, such as higher rates of lateral condyle fractures, triceps and ulnar nerve dislocation, medial and lateral elbow pain, posterior shoulder instability, and ulnar nerve neuritis [5,8].

French, in 1959, reported a procedure that, "gives a good exposure, robs the operation of some of its dangers, provides a method of satisfactory control of the osteotomy and allows for earlier mobilization of the elbow" [9]. French offered a corrective lateral osteotomy of the distal humerus using the medial wall as a hinge. This procedure included a fixation of the osteotomy by two screws and a wire. Since then, many methods have been described for fixation of the osteotomy and for the osteotomy itself [10]. Satisfactory results of the French technique for corrective osteotomy have been reported by many surgeons, although complications of the French technique have also been published, such as residual deformity, lateral prominence, loss of fixation, and ulnar nerve palsy [11].

Our study was designed to evaluate the long-term outcome of the French osteotomy technique for cubitus varus deformity. The study carries great significance since the ethnic and demographic characteristics of our geographic area allow long-term follow-up. The objective of this study is to describe the isosceles-triangle osteotomy of the distal humerus, a technique that, to the best of our knowledge, has not been described. We believe that this technique can prevent complications of lateral prominence after French osteotomy.

PATIENTS AND METHODS

Ten children underwent supracondylar humeral osteotomy by the French technique for post-traumatic cubitus varus defor-

mity between 1998 and 2012. The patients' condition was followed and the results of the technique were documented in our computerized database from the day of the surgery until July 2012. Physical examination recording the range of motion, cosmetic deformity, and other postoperative complications were assessed, as was patient satisfaction. Anteroposterior and lateral radiographs of the operated elbow and the healthy elbow were obtained. Carrying angle, hyperextension, and lateral cortex prominence were measured and recorded in both operated and healthy elbows before and after the operation [Figure 1, Figure 2]. The medical history of all patients remained confidential and each patient was identified by a code only. The study was approved by the institutional review board.

SURGICAL TECHNIQUE

Anteroposterior radiographs of both upper extremities were reviewed before surgery, and the amount of surgical correction required to achieve symmetry was determined. The carrying angle was measured in both healthy and post-traumatic elbows [Figure 1]. The normal average carrying angle is +8 degrees. Our patients had a negative carrying angle. Based on the difference in the carrying angle, we decided the distance between the two points of the osteotomy (the length of the base of the triangle). The height of the osteotomy was also decided according to the center of the rotation.

After preoperative planning was completed, the patient was brought to the operating room and placed in a full supine position with the affected extremity on a radiolucent hand table. The ability to achieve adequate fluoroscopic images of the elbow in anteroposterior and lateral planes needed to be established before prepping and draping of the affected extremity.

Proper patient positioning is essential to maintain control of the distal humeral fragment, which is small, after the osteotomy. After exsanguination and inflation of a pneumatic tourniquet, the humerus was approached through a small lateral incision directly over the supracondylar ridge, which was exposed subperiosteally. Two Kirshner wires and screws were inserted according to the preoperative planning [Figure 3]. In some cases, in which additional rotational deformity was identified, correction was attempted by placing the screws in different positions in the sagittal plane. The wedge was cut by a saw, leaving the medial cortex intact to be cracked as a hinge, thereby approximating the screws. The screws were then wired in a figure eight pattern [Figure 4] and the incision was closed. After standard closure of the incision, the extremity was placed in a long-arm cast with the elbow flexed to 90 degrees. The cast was univalved to allow for swelling. Mobilization was started after 3 weeks.

RESULTS

The study comprised a total 10 patients (8 males and 2 females). The right side was involved in eight cases and the left side in

Figure 1. Preoperative carrying angle

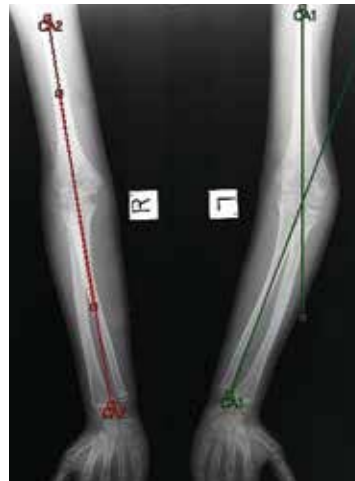


Figure 2. Postoperative carrying angle

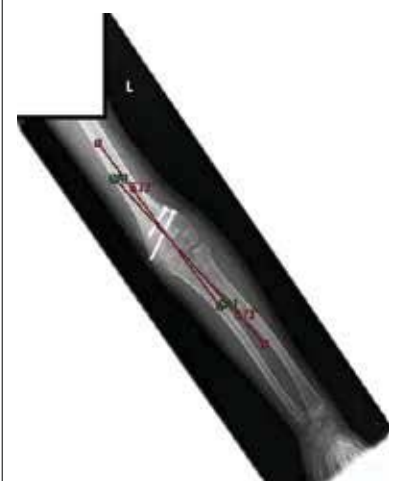


Figure 3. Kirshner wires marking the place for the osteotomy



Figure 4. Screws wired in a figure eight pattern fixating the osteotomy



two cases. Three patients were excluded because of incomplete data. In three patients, clinical different rotations of 20 degrees between the elbows was noticed, which had minimal clinical implication. However, we were able to correct this deformity by placing the screws in different positions in the sagittal plane.

The average time of follow-up was 4.6 years (range 2–9 years). An average of 18.3° of limited flexion (range 5°–35°) compared to the healthy elbow was recorded in three patients. All patients had full pronation-supination range of motion both pre- and post-surgery. The average preoperative carrying angle -20.5° (range -15°–30°) and postoperative angle was 9.6° (range 7°–13°). In comparison, the average carrying angle in the healthy elbow was 8.5° (range 4°–13°). No lateral cortex step was recorded. An average of 27.5° (range 15°–35°) of hyperextension of the distal fragment was recorded immediately after the surgery in four patients. However, during postoperative follow-up, the hyperextension corrected spontaneously. Out of seven patients, six were satisfied with the surgical results. One patient expressed dissatisfaction due to the range of elbow motion achieved post-surgery: 20 degrees of hyperextension, and only 120 degrees of flexion.

DISCUSSION

Cubitus varus is typically the result of a malunion, as opposed to a disturbance in growth, which will neither correct nor progress with time. The distal fragment is typically in varus, with variable extension and internal rotation. Numerous methods for correcting cubitus varus have been described; however, there is still no consensus on which method yields the best results with the fewest complications [12].

Operative intervention has been advocated primarily for the correction of the cosmetic deformity. However, several researchers [13–16] have reported an association between cubitus varus and other musculoskeletal sequelae. Pain, functional limitations, and delayed onset neuropathies have been reported. All of our patients had endured cosmetic deformity. An average of 18.3° of limited flexion (range 5°–35°) compared to the healthy elbow was recorded in three patients. However, we used the carrying angle as the objective tool for measuring the amount of cubitus varus (negative angle) or valgus (positive angle). The average preoperative carrying angle was -20.5° (range -15°–30°) and postoperative angle was 9.6° (range 7°–13°). In comparison, the average carrying angle in the healthy elbows was 8.5° (range 4°–13°).

The most popular method used to correct cubitus varus deformity consists of a lateral closing wedge osteotomy of the distal humerus [17,18]. The method attempts to preserve the medial cortex and/or periosteum as a hinge to give some inherent stability to the osteotomy site. One potential consequence reported to be associated with these types of osteotomies has been the creation of a prominent lateral condyle [19–21]. In our

study, we emphasize the importance of the surgical technique to ensure the osteotomy is arranged in an isosceles-triangle shape to prevent the lateral cortex step, which could result in an iatrogenic cosmetic deformity.

In our series, all patients were treated by the French technique. While performing the surgery, particular attention was given to perform the osteotomy exactly as planned during the preoperative phase – in an isosceles-triangle shape – with the base of the triangle as the lateral cortex to prevent the cosmetic deformity of lateral cortex prominence. Thus, none of our patients had experienced prominent lateral condyle.

Raney and co-authors [22] published a review spanning 50 years of follow-up for 68 patients who underwent variable corrective osteotomies for cubitus varus deformity. All patients in the series underwent one of the many described versions of the lateral closing wedge osteotomy, including oblique cuts and step cuts. The surgical approaches were either posterior, lateral, or transolecranic. Seven different fixation techniques were used among casts, pins, tension band wires, and plates. Seventeen patients (25%) had 23 (34%) clinically remarkable complications. Nine postoperative nerve palsies occurred in eight patients. Loss of reduction requiring revision or manipulation was seen in three patients. The following complications were each noted in two patients: nonunion, loss of flexion, lateral prominence, and unsatisfactory scar. Growth arrest, osteomyelitis, and under-correction requiring revision each occurred once. In our study, since we used the lateral approach for the lateral cortex for obvious reasons, there was no nerve palsy or neuropraxia. We used two screws instead of two Kirshner wires and a figure eight pattern, which provided a rigid fixation of the osteotomy; thus, none of our patients endure loss of fixation.

North and colleagues [23] confirmed the results of the French osteotomy with more technically demanding osteotomies by reviewing 90 consecutive patients. The results of our study are comparable to those described by North et al. The French technique has fewer complications compared to the more technically demanding dome, step-cut translation, and multiplanar osteotomies.

We did not notice any posterolateral rotatory instability post-surgery in our patients. Such an instability post-surgery was noticed in 5 out of 22 patients in a study by Seo et al. [24]. Their study differed from ours in that the average time between initial trauma of the patients and corrective osteotomy in theirs was 30 years and subtle elbow instability before the corrective osteotomy might have been presented due to the long standing cubitus varus. The authors assume that postoperative instability might have also been related to medial translation of the osteotomy they performed.

In our study, an average of 27.5° (range 15°–35°) of hyperextension of the distal fragment was recorded immediately postoperative in four patients; however, during postoperative follow-up, the hyperextension corrected spontaneously. In

essence, the French technique osteotomy is uniplanar, designed to correct only the cubitus varus coronal plane deformity. Some rotational deformity correction is also possible. Any deformity in the sagittal plane is not affected by the osteotomy. We agree with the conclusion of Simanovsky and co-authors [25] that malunion of supracondylar fractures in extension do not tend to remodel over time.

The main limitations of our study are the small number of cases and the study's retrospective nature.

CONCLUSIONS

As already described, the French technique of supracondylar osteotomy has excellent results in the management of post-traumatic cubitus varus in terms of cosmetic, function and radiological findings. We emphasize the importance of the surgical technique by giving particular attention to making the osteotomy in an isosceles-triangle shape to prevent the lateral cortex prominence and later on an iatrogenic cosmetic deformity. In addition, although not yet proven, our findings supports the assumption that hyperextension in the sagittal plane might be corrected spontaneously, but further investigation in needed.

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Capsule

A study on characteristics of rheumatoid arthritis patients achieving remission in depression with 6 months of bDMARDs treatment

Miwa and colleagues investigates the relationship between baseline factors and depression remission after a 6 month biological disease-modifying antirheumatic drugs (bDMARDs) treatment in rheumatoid arthritis (RA) patients. The study was conducted in 152 RA patients treated with bDMARDs. Based on binominal logistic analyses, RA patients with depression remission (n=124) compared to those without depression remission (n=28) had a younger age ($P = 0.0045$, odd ratio

[OR] 0.94, 95% confidence interval [95%CI] 0.8–0.98), female gender ($P = 0.021$, OR 0.21, 95%CI 0.054–0.79), and lower HAM-D scores ($P = 0.0073$, OR 0.85, 95%CI 0.76–0.96). The authors propose that RA patients who are female, younger in age, and have lower depressed scores at baseline can achieve a depression remission status with the bDMARDs treatment.

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