IMPACT OF PLATE POSITIONING ON THE LATERAL CLOSING WEDGE OSTEOTOMY FOR CUBITUS VARUS

MIN YU, WAN-CHUN WANG, JIANG-DONG NI, YU-JIA LI

ABSTRACT

Objective: To study the effects of low intensity ultrasound irradiation applied on the spinal cord, in the regeneration of the rat's sciatic nerve after a controlled crush injury, evaluating the functional results of the sciatic functional index as measured on video recorded images of the foot sole. Methods: Eighteen rats were submitted to a controlled crush injury of the right sciatic nerve, and divided into two groups according to the treatment: Group 1 (n=9), simulated irradiation; Group 2 (n=9), effective irradiation. Low-intensity ultrasound irradiation was started on the 7th postoperative day and applied daily for 6 weeks. Images of the animals´ foot soles were video recorded on a transparenttreadmill belt at weekly intervals until the 6th week of irradiation, and the corresponding sciatic functional index (SFI) was measured usingspecific software. Results: The SFI during the first and last week of treatment was -59.12 and -12.55 in Group 1, -53.31 and -1.32 in Group 2, indicating improvements of 79% and 97%, respectively, but differences between the groups were only significant ($p<0.05$) during the third week of treatment. Conclusion: The authors conclude that low intensity therapeutic ultrasound enhances nerve regeneration, with significance during the 3rd week of treatment. Level of Evidence: Level II, prospective comparative study.

***Keywords*:** Internal fixators. Osteotomy. Bone plates. Bone screws.

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INTRODUCTION

Cubitus varus is the most common angular deformity of the supracondylar fracture in children and adults. There are many relevant factors that contribute toward the deformity, such as poor reduction, poor union or non-union, bone bar in physes and so on. However, the entrance and the rotation of the distal fragment of the fracture and the poor union of the supracondylar fracture are considered the most common general causes. We emphasize that the end of growth is another factor that causes progressive cubitus varus deformity, which is coherent with the reports of Theruvil *et al*.[1] and Voss *et al*.[2] The latter mentioned that the immediate and late causes of cubitus varus are medial angulations, medial rotation, super-growth of the lateral condyle and osteonecrosis or medial condyle growth retardation. The pathogenesis of the angular deformity of the elbow after supracondylar humerus fracture has not yet been elucidated. Although the elbow functions of patients with cubitus varus are not significantly impaired, the deformity leads many patient or their parents to request surgical correction to improve appearance of the arm. Correction of the angulation deformity using osteotomy is a surgical principle, fundamentally split into three essential categories: medial opening wedge osteotomy with bone graft, oblique and rotating osteotomy and lateral closing wedge osteotomy. According to these surgical principles, it appears that there are many methods capable of fixing the deformity, such as cross-pin fixation, compression plate, U-shaped pin, coil thread screws and external fixation.[3-12] Each procedure has its own advantages and disadvantages. The disadvantages are deformity recurrence, infection of the pin orifice, osteomyelitis and nerve paralysis. Moreover, there is no consensus about which procedure has the best result, especially in children. Therefore, the selection of the appropriate surgical procedure depends on the preferences and on the experience of the surgeon. With a basis on our experiment and on earlier reports, lateral closing wedge osteotomy is the safest and easiest technique, with inherent stability. However, the influence of the location of the internal fixation and of the plate on the effectiveness of surgery has rarely been discussed in the past. That being the case, the aim of this study is to attempt to evaluate the impact (posterolateral side and lateral side) in lateral closing wedge osteotomy in cubitus varus.

MATERIALS AND METHODS

Twelve patients were recruited and treated with lateral closing wedge osteotomy plus internal fixation with plates and screws in the Department of Orthopedics of the Second Xiang-Ya Hospital of the Central South University, in China, between January and June 2009. Seven of the 12 patients were men and five,

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women. The mean age was 9.6 (from 4 to 17 years). None of them exhibited late ulnar nerve paralysis or functional deficiency before the surgery. The clinical and radiographic evaluations of the upper limbs were performed before the surgery. The loading angle was measured by the angle formed between the longitudinal axis of the arm and of the forearm, in total extension of the elbow and supination of the forearm. The range of motion (RM) of the elbow was assessed and compared with the normal arm. The patients were randomly divided into two groups (A and B). Group A corresponds to the plate fixed on the posterolateral side and group B, to the plate fixed on the lateral side of the humerus.

PREOPERATIVE PREPARATION

Before the surgery, we measured the varus angle (X) of the deformed elbow and the loading angle (Y) of the healthy side of the arm in each patient. We then calculated the angle of correction (X+Y). In the radiographies, we marked a line parallel to the humerus on the articular surface of the elbow, 0.5 cm above the upper edge of the olecranon fossa. Next we marked another line intersecting the first on the medial cortex of the humerus, which constituted the angle equal to X+Y. In verifying the scale of radiographies, we obtain the length of the wedge to be excised during surgery. (Figure 1)

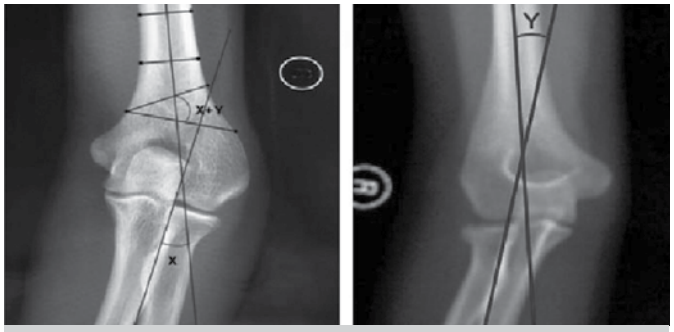

Figure 1. *Osteotomy method: the varus angle (X) of the deformed side and the loading angle (Y) of the healthy side*.

SURGICAL PROCEDURES

The surgery was performed under general anesthesia and with tourniquet control, and the patients' arms were placed in supine position on the hand operating table. Group A was operated with a plate in posterolateral location and group B, with a plate in the lateral location, with a 3 to 4 cm skin incision along the anterior edge of the brachial triceps to expose the distal segment of the humerus. Two K-wires (2.0 mm) were introduced along the marked lines and the bone was cut along these wires. The anterior cortex should be cut slightly more to ensure the anatomical shape of the distal part of the humerus. The wedge was removed, reduced (protecting the medial cortex and the periosteum) and fixed internally with a reconstruction plate and common screws (group A in the posterolateral direction and group B in the lateral direction). The removed sphenoid bone was broken into pieces and compacted around the fracture. The wound was closed and the upper limb was immobilized with external fixation (plaster cast or orthosis). The pre and postsurgical radiographies are shown in Figures 2 and 3.

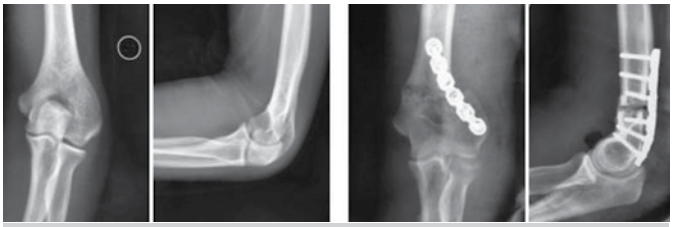

Figure 2. *Pre - (1) and postoperative (2) radiographies of patient from group A. The humeral anteversion angle, which is close to the normal anatomy, is observed in the postoperative radiography.*

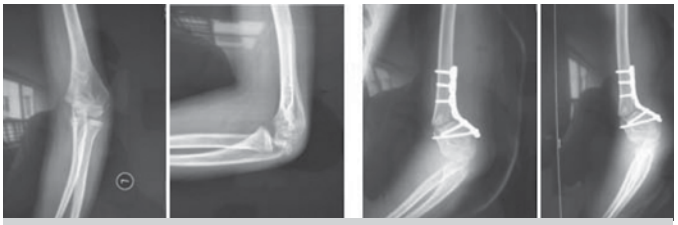

Figura 3. *Pre- (1) and postoperative (2) ARTIA radiographies of patient from group B. The plate was pre-curved to adapt to the arc of the distal segment of the humerus.*

RESULTS

All the patients were monitored for about 4.5 months (ranging from 2 to 7 months). In group A, the mean varus angle was -29.5°, with variation from -25° to -36°, and it was corrected to mean valgus angle of 8°, ranging from 5° to 11°. In group B, the mean varus angle was -29°, with variation from -20° to -38°, and it was corrected to mean valgus angle of 8°, ranging from 7° to 13°. In all cases, the appearance is very similar to the opposite side. No differences were observed in the range of motion (ROM) of the elbow between the two groups. In group A, the mean range of motion of the elbow joint was from 2.7° of extension (range 0°-6°) to 141° of flexion (range, 135°-148°) in the preoperative period, and from 1° of extension (range, 0°- 4°) to 143° of flexion (range, 135°-150°) in the postoperative period. In group B, the mean range of motion of the elbow joint was from 3.2° of extension (range, 1°-7°) to 142° of flexion (range, 138°-145°) in the preoperative period and from 2.0° of extension (range, 1°-5°) to 143.5° of flexion (range, 138°-150°) in the postoperative period. There were five excellent results (83.3%) and one good result (16.7%) in each group. A patient in group B had transient nerve paralysis; there were no infections or osteomyelitis. (Table 1)

DISCUSSION

Cubitus varus is the most common prolonged complication of the supracondylar humerus fracture in children, with incidence ranging from 4% to 58%.[4,13] Flynn *et al*.[14] emphasized that, although the use of percutaneous procedures has significantly reduced the incidence of cubitus varus deformity, 5% to 10% of children with supracondylar humerus fractures still develop this deformity in spite of treatment. There are still reports of the incidence of cubitus varus ranging between 10% and 57%, regardless of the treatment method.[15-18] In the majority of patients, the general complaint is the deformity and not the functional disability.[19] Nevertheless, cubitus varus deformity causes

Table 1. *Details of 12 patients treated with lateral closing wedge osteotomy in cubitus varus.*

Case	Age (years)	Gender	Loading angle (degrees)		Flexion (degrees)		Complications	Results
			pre-op.	Post-op.*	pre-op.	post-op.		
1	13	M	-27	10(8)	5-145	1-145		excellent
2	7	M	-31	7(9)	3-148	0-150		excellent
3	10	F	-25	11(8)	0-135	0-135		excellent
4	6	M	-30	5(10)	6-140	4-145		excellent
5	17	F	-28	9(10)	2-135	1-135		excellent
6	4	F	-36	6(12)	0-145	0-145		good
7	12	F	-30	9(13)	3-140	2-141		excellent
8	7	M	-38	7(8)	1-145	1-145	transient nerve paralysis	good
9	10	M	-24	8(6)	7-140	5-142		excellent
10	15	M	-20	13(7)	5-138	2-138		excellent
11	8	F	-27	11(10)	1-143	1-145		excellent
12	6	M	-35	6(11)	2-145	1-150		excellent

*the numbers between brackets are the loading angles of the healthy opposite side Group A (cases 1-6); Group B (cases 7-12)

traumatic lateral condylar fracture of the humerus, posterolateral rotatory instability and mediocre aesthetic results.[20-23]

Several surgical procedures for cubitus varus correction, such as lateral closing wedge osteotomy, step-cut osteotomy and dome osteotomy, are performed frequently. Some authors reported that dome osteotomy and step-cut osteotomy, which avoid lateral condylar prominence, produced satisfactory results.[24-28] However, lateral closing wedge osteotomy of the humerus is an efficient technique to correct cubitus varus,[29,30] which does not cause lateral condylar or scar prominence, and produces excellent results.[2,31] Almost all the authors used internal and external fixation after using this technique, but the plate position was seldom discussed. Some authors, considering the fact that the lateral side is, in general, the site of tension,[32] positioned the plate in this region. However, in our study, we used the same body position and the same modality; the mean varus angle in the preoperative period was 29.5° in group A and 29° in group B, and the mean loading angle in the postoperative period was 8° to 9°, respectively. No statistical differences were found in terms of pre-surgical varus angle and correction angle, appearance, range of motion and function of the elbow joint between the groups of plate on the posterolateral side and on the lateral side of the humerus, neither were there any differences in terms of poor union and non-union of the humerus and complications in both groups.

CONCLUSION

Lateral closing wedge osteotomy is the safest and most effective procedure to correct cubitus varus deformity. The internal fixation plate position has no impact on lateral closing wedge osteotomy.

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