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ORIGINAL PAPER

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Primary bone grafting does not improve the results in severely displaced distal radius fractures

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Abstract We prospectively randomised 45 patients ages 20–70 years with distal radius fractures of Older type III and IV to one of two treatment groups. One group was treated with closed reduction, primary bone grafting, and external fixation for 3 weeks, followed by a plaster cast that allowed volar flexion, for an additional 3 weeks. The other group was treated with closed reduction and external fixation for 6 weeks. The functional and radiographic results were evaluated. There was no difference between the two groups in either clinical or radiographic outcome. We do not recommend external fixation and primary bone grafting as a routine method in these fractures.

Résumé Nous avons randomisé 45 malades avec une fracture du radius de type III et IV d'Older, âgés de 20 à 70 ans, en deux groupes de traitement. Un groupe a été traité par réduction fermée, greffe osseuse primaire et fixation externe pour trois semaines suivie par une contention plâtrée en flexion palmaire pour trois semaines supplémentaires. L'autre groupe a été traité par réduction fermée et fixation externe pour six semaines. Les résultats fonctionnels et radiographiques ont été évalués. Il n'y avait aucune différence entre les deux groupes pour les résultats cliniques et radiographiques. Nous ne recommandons pas la fixation externe avec greffe osseuse primaire comme une méthode habituelle de traitement de ces fractures.

Introduction

In comminuted fractures with large bone defects, e.g. the proximal tibial plateau fracture, the usual orthopaedic practice is to use bone grafts to restore continuity and stability in the fracture area. An additional advantage is that this procedure often allows the surgeon to reduce the adjoining joint surface. The problem with comparatively large bone defects and instability also applies to distal radius fractures. However, bone grafting for this fracture was not described until Leung et al. [4] reported in 1989 on a series of 72 severely displaced distal radius fractures treated with bone grafting and external fixation. Their results were excellent although somewhat difficult to evaluate due to lack of a control group. In the present study we compared Leung's technique with our standard treatment, i.e., closed reduction and external fixation.

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Patients and methods

Patients

We studied 48 patients aged 20–70 years with severely displaced and comminuted distal radial fractures. All patients had suffered from a distal radius fracture classified as Older class III (dorsal radius comminuted, radial styloid process shortened more than 4 mm distal to ulna) or IV (marked comminution and the radial styloid process shortened to the level of ulna or less) [7]. Patients with earlier injury of either wrist were excluded. The patients had been treated at the emergency departments of Löwenströmska and Karolinska Hospital, Stockholm, Sweden 1990–1994. All gave their informed consent for inclusion in the study, which was approved by the ethics committee at Karolinska Hospital. The patients were allocated to one of two groups just before the operation by means of a table of random numbers.

The first group (bone graft group) consisted of 16 women and eight men. One patient moved abroad and could not be reached, leaving 15 women and eight men for evaluation. Their mean age was 51 (25–69) years. These patients were treated under general anaesthesia with external fixation, primary bone grafting, and early mobilisation. For external fixation we used a half-frame Hoffmann external fixator. The proximal pins were inserted into the radius 3–4 cm proximal to the fracture line. The distal pins were inserted in the second metacarpal bone. Under fluoroscopic control the fracture was reduced and the reduction was maintained by tightening the joints of the frame. A 3- to 4-cm-long incision was made at the dorsum of the wrist to expose the fracture area. Cancellous bone graft was harvested from the iliac crest and packed into the fracture cavity. Displaced fracture fragments were further reduced to obtain joint congruity and restore radius length. The external fixator was maintained for 3 weeks, after which a plaster

Table 1 Functional results. Ratio to the uninjured contralateral side

	Flexion/extension Mean (SD)	Pronation/supination Mean (SD)	Grip strength Mean (SD)
Bone graft group	78% (15)	96% (10)	77% (17)
[Range]	[54–100%]	[75–113%]	[57–100%]
Control group	78% (18)	95% (10)	79% (18)
[Range]	[50–113%]	[67–100%]	[44–120%]
P-value	0.94	0.78	0.69

cast was applied and kept for an additional 3 weeks. The cast allowed volar flexion but limited extension.

The second group (control group) consisted of 17 women and seven men. Two patients declined participation in the final evaluation, leaving 16 women and six men. Their mean age was 52 (20–69) years. This group was treated with closed reduction and external fixation for 6 weeks. The external fixation was performed as described above. The operation was performed under regional intravenous block.

Radiological reviews were done preoperatively, postoperatively, and after 12 months, and used anteroposterior and lateral views of both wrists. Dorsal angulation and radial shortening were measured, and the results were expressed in degrees and millimetres respectively. The fractures were also classified according to the AO group [5] and Older [6].

The clinical outcome was evaluated at 12 months. At this examination the ranges of motion (ROM), (flexion/extension and pronation/supination) were measured with a goniometer and the grip strength with a vigorimeter. Grip strength was not corrected for dominant vs nondominant side. The results were expressed as a percentage of the uninjured side.

Statistics

For the nonparametric data the Fisher exact test and the chi-square test were used. The parametric recordings were evaluated by means of analysis of variance (ANOVA). With 80% power (20% type-II error), 5% level of significance, and one-sided hypothesis, a difference of 8–12% would have been possible to detect with regard to the considered variables of Table 1.

Other comparisons made were with respect to control factors only and should not be considered as primary responses, nor, therefore, undertaken in power calculations.

Results

Functional results

The functional results were almost identical in both groups (Table 1). Five bone-graft patients and three control-group patients had grip strength under 60% of that of the uninjured wrist. Two patients in each group had bad function as end result (less than 50% grip strength and 50% ROM).

Radiological results

The distribution of severity of fracture displacement was almost equal in both groups (Tables 2 and 3). Table 4 shows the degree of dorsal angle and radial shortening. Initial fracture displacement and final result at the 12-month radiological review showed no significant difference between the two groups. One patient in the control group healed with a severe malunion (volar angle of 34 degrees and an ulna plus of 6 mm). Two patients in the bone graft group healed with a radius shortening of >5 mm. No other patient healed with a severe malposition.

Table 2 Distribution of patients in Older classes. There was no difference in distribution between the two groups. *P*-value=0.758, Fisher's exact, two-tailed test

	Older class	
	III	IV
Control group	15	7
Bone graft group	14	9

Table 3 Distribution of patients in AO classes, There was no difference in distribution between the two groups. *P*-value=0.199, Exact chi-square test for trend

	AO class					
	A2	A3	C1	C2	C3	Total
Bone graft group	0	7	1	6	9	23
Control group	1	10	0	5	6	22

Table 4 Dorsal angle (*DA*) of distal radial surface in relation to the long axis of radius, measured on lateral radiographic view. Positive value dorsal-tilted, negative volar-tilted. Axial radial shortening (*ARS*) is difference in millimetres between distal ulnar surface and ulnar part of distal radial joint surface, measured on anteroposterior radiographs. *Positive value* is when radius is longer than ulna. *Negative value* is when radius is shorter than ulna. The table shows the values preoperatively, postoperatively, and 1 year after operation. There was no difference in any of the parameters between the two groups

	Radiographic results					
	DA Preop Degrees	DA Post-op Degrees	DA 1 yr Degrees	ARS Preop Mm	ARS Post-op Mm	ARS 1 yr Mm
Bone graft group	30±8	–3±8	–9±11	–6±2	0±2	–2±2
Control group	28±13	–3±6	–8±10	–7±3	0±2	–2±2

ANOVA of DA, bone graft group vs control group *P*=0.225
ANOVA of ARS, bone graft group vs control group *P*=0.908

Complications

There was one deep pin-tract infection with an abscess requiring drainage in the control group, and one patient developed a carpal tunnel syndrome requiring surgery. In the bone-graft group one patient sustained a rupture of the extensor pollicis longus tendon; another needed surgery for a superficial painful granuloma. The only serious donor site complication was that one patient had bleeding on the first postoperative day, but this ceased after compression.

Discussion

Several authors have shown that radius shortening is the most significant indicator of the clinical outcome in severely displaced distal radius fracture [1, 7, 8]. In this type of fracture, closed reduction and external fixation for 6 weeks has been our standard treatment. This treatment is successful in retaining the radial length but makes it difficult to reduce joint incongruity in intraarticular fractures. Six weeks of ligamentotaxis also seems to give the patient joint stiffness. The method described by Leung gives the opportunity to retain radial length and restore joint incongruity, and also allows early mobilisation. We thought this was a very promising method, but, contrary to our expectations, we found no improvement either radiographically (radial shortening and dorsal angulation) or clinically compared to our standard treatment. Notably, our results in *both* groups were very similar to those presented by Leung. There is, however, a difference in mean age between our patients and Leung's (52 vs 36 years). Solgaard showed in 1984 [7] that age is one of three major factors that influence the functional end result, and older patients have a worse prognosis. It is therefore surprising to find that our results tally with Leung's. On the other hand, Leung's series included 90% intraarticular fractures, which probably have a negative influence on the final outcome. In our control group 11 of 23 patients had intraarticular fractures as did 16 of 24 in the bone graft group.

Our reason for selecting the classification system described by Older et al. in 1965 was that it proved to be superior to other systems for predicting clinical outcome [7]. The Older system also has been tested for consistency, with kappa values of 0.75 and 0.69 for intraobserver and interobserver agreement respectively [2]. The weakness in the Older classification system is that it applies mainly to extraarticular fractures and thus may not be useful for discriminating severity in intraarticular fractures. The early mobilisation in the bone graft group did not appear to influence outcome after 12 month. We expected that the bone graft and open reduction would improve the radiographic and clinical results. Kinninmont et al. 1987 [3], showed in a cadaver study that packing cancellous bone chips into these comminuted fractures increased the rigidity of reduction fourfold. Nevertheless, the bone graft group in our study did no better radiographically than the control group.

We found no advantage in using open reduction, primary bone grafting, and external fixation in complex distal radius fractures. The method might, however, have a place in very selected cases with a large bone defect and where the surgeon wants the opportunity to reduce a significant joint incongruity.

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References

1. Abbaszadegan H (1989) Prediction of instability of Colles' fractures. Acta Orthop Scand 60:646–650
2. Andersen GR, Rasmusen J-B, Dahl B, Solgaard S (1991) Older's classification of Colles' fractures: good intraobserver and interobserver reproducibility in 185 cases. Acta Ortop Scand 62:463–464
3. Kinninmonth A, Evans JH, Leung PC (1987) A biomechanical study of comminuted distal radial fractures to asses the stabilising effect of primary bone grafting. The Hong Kong Orthopaedic Association 7th annual scientific congress, November 1987
4. Leung KS, Shen WY, Leung PC, Kinninmonth AWG, Chang JCW, Chan GPY (1989). Ligamentotaxis and bone grafting for comminuted fractures of the distal radius. J Bone Joint Surg [Br] 71:838–842
5. Müller ME (1991) The principle of classification. In: Müller ME, Allgöwer M, Schneider R, Willenegger H (eds) Manual of internal fixation: techniques recommended by the AO-ASIF group. Springer, Berlin Heidelberg New York, p. 11
6. Older TL, Stabler EW, Cassebaum WH (1965) Colles' fracture: Evaluation and selection of therapy. J Trauma 5:469–476
7. Solgaard S (1984) Classification of distal radius fractures. Acta Orthop Scand 56:249–252
8. Villar RN, Marsh D, Rushton N, Greatorex RA (1987) Three years after Colles' fracture. J Bone Joint Surg [Br] 69:635–638