



Correction of nascent malunion of distal radius fractures

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Objective: Early correction of malunion of distal radius fractures may be necessary in young, active patients. The aim of this study was to report the advantages and disadvantages of early correction of distal radius malunion.

Methods: Eleven patients (10 male, 1 female; average age 36 years, range: 20 to 54 years) with nascent malunion of distal radius fractures were included in this study. The malunions occurred after initial conservative treatment of unstable distal radius fractures. Mean interval between injury and corrective surgery was 12 (range: 8 to 15) weeks. Two patients had intra- and extra-articular malunion and 9 had an extra-articular malunion. Volar correction was made in seven patients and dorsal correction in four. Results were evaluated radiologically and functionally using the Mayo wrist score.

Results: Bony healing was established after correctional osteotomies at an average of 8 (range: 5 to 16) weeks. The average preoperative dorsal deformity was 28° and was corrected to 4° of volar tilt postoperatively. Patients had a positive ulnar variance with an average of 5 mm initially and less than 1 mm postoperatively. Radial inclination was corrected from an average of 9° preoperatively to an average of 20° and the average postoperative Mayo wrist score was 82.5. Tenotomy of brachioradialis was useful for the correction of radial inclination, especially in old cases. Structural (corticocancellous) grafting was used in one patient. All patients returned to their previous functional level.

Conclusion: Advantages of early corrective osteotomy include anatomic restoration at the original fracture line, a shortened healing period and a decreased need for structural bone grafting. Disadvantages are that the recreation of the original fracture line is technically demanding and patients must be cooperative to achieve a successful outcome.

Key words: Corrective osteotomy; distal radius fracture; malunion.

Distal radius fractures are the most frequent fractures in orthopedic traumatology and are mainly treated in emergency rooms.^[1] Incidence rates increase in two groups; with high energy traumas responsible for majority of fractures in young and active individuals, and low energy traumas in old individuals.^[2] Although malunion rates as high as 60% have been reported, only approximately 5% of distal radius fractures need

corrective osteotomies.^[3,4] Older individuals have better adaptation to the resulting deformity.^[5] No complete agreement on the treatment modality for nascent malunion of distal radius fractures exists.^[1] Some authors have defined the surgical indications and noted that patient selection is very important for a successful outcome.^[6] The aim of this retrospective study was to determine the advantages and disadvantages of correc-

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Fig. 1. (a) Anteroposterior X-ray of an 8-week-old malunion of the distal radius. Significant decrease in radial inclination and height is observed. (b) Dorsal angulation is clearly seen in the lateral view. (c) Radial inclination and height is improved after dorsal osteotomy and fixation. (d) Dorsal angulation is corrected to almost 0° after operation.

tion of nascent malunions of distal radius in young, active patients.

Patients and methods

We retrospectively reviewed 11 patients (10 males, 1 female) who underwent corrective osteotomy for a nascent malunion of distal radius fractures between January 2002 and November 2009. All patients were young (mean age: 36 years; range: 20 to 54 years), active patients. The average follow-up period was 28 (range: 6 to 91) months. Malunion developed following the conservative treatment of unstable distal radius fractures in all cases. There were intra and extra-articular malunion in 2 cases, and extra-articular deformities in 9 cases. Correction was performed at an average of 12 (range: 8 to 15) weeks after the initial trauma. Volar correction was performed in 7 cases and dorsal correction in the other 4 cases (Figs. 1 and 2). Structural bone grafting was performed in one case.

Cancellous bone grafting was necessary in 6 cases and callus of the fracture were used instead of bone grafting in 4 cases. Results were evaluated radiologically and functionally using the Mayo wrist score (Table 1). Detailed demographic and clinical data are presented in Table 2.

Results

Bony healing was established at an average of 8 (range: 5 to 16) weeks following correctional osteotomy. Bony union at the osteotomy site was assessed radiologically using anteroposterior and lateral radiographs of the wrists and through clinical examination. Postoperative immobilization was applied in all cases using a short arm splint for 4 weeks. Delayed union occurred as late as the 16th week in one case in which early hand rehabilitation was initiated due to the appearance of early symptoms of reflex sympathetic dystrophy. Both this patient and another in which union was achieved 10



Fig. 2. (a) Anteroposterior X-ray of a 10-week-old malunion of the distal radius. Radial inclination and height was calculated as 11° and 5 mm respectively preoperatively. (b) Dorsal angulation was 10° on the lateral X-ray. (c) 3D CT image was used to determine the original fracture line and osteotomy site in this case. (d) Corrective osteotomy was performed with volar approach and locking plates were used for fixation and previous callus was used as bone graft. Radial inclination and height is significantly corrected in the anteroposterior view. (e) Volar tilt is reestablished as seen in the lateral view.

weeks after osteotomy were heavy smokers. Dorsal deformity was corrected from a preoperative 28° to about 4° volar tilt postoperatively. Average ulnar positive variance was lowered from 5 mm to below 1 mm. Mean radial inclination was corrected from 9° to 20°. Two patients who had intra-articular involvement at the volar side were anatomically restored (Table 2). The average Mayo wrist score was 82.5. Three cases were evaluated as excellent, 4 cases as good and 4 cases as satisfactory (Table 1). Brachioradialis tenotomy was used in the restoration of radial inclination in all cases with an interval of 10 or more weeks between the initial trauma and correction. Corticocancellous grafting was performed in a case where decreased bone quality in the distal part of the osteotomy was insufficient for stable fixation. Iliac cancellous grafting was used in 6 cases and callus at the fracture site was used instead of bone grafting in the remaining 4 cases. All patients returned to their previous functional level.

Discussion

Anatomic restoration is necessary to maintain sufficient function of the wrist following distal radius fractures. A dorsal angulation of over 12° will result in significantly worse grip strength, range of motion and functional outcome, as compared to dorsal angles below 10°. [7] Cadaveric studies have demonstrated an increase and dorsoulnar migration of radiocarpal pressure and a shift in the instant center of rotation during pronation and supination with increased dorsal and radial angulation and loss of radial height. [8-10] It is still not clear why posttraumatic radiocarpal arthritis develops in some patients and not in others. [2] Parallel to the increase in knowledge of carpal kinematics, it is now understood that intra-articular displacement, radiocarpal sequential order defects and ligament lesions

between carpal bones disturb harmonious functioning and play a role in early osteoarthritis. The accumulation of information and knowledge explains the increasing tendency towards surgical methods for the treatment of displaced distal radius fractures. [2]

Although a 60% malunion rate is recorded, only about 5% of these cases require corrective osteotomy. [3,4] Here, the surgeon faces an important dilemma: to perform early correction in cases with nascent malunion of the distal radius, or delay the corrective osteotomy until the maturation of the malunion.

The indications of early corrective surgery in distal radius nascent malunion are defined in the literature as follows; identification of 20° or more dorsal angulation in lateral radiographs, intra-articular displacement of more than 2 mm, more than 15° of dorsal angulation of the lunate, dislocation in the distal radioulnar joint, and radiocarpal subluxation in marginal slide fractures. [6]

In two of our cases, early correction restored the intra-articular displacement, which was likely to cause radiocarpal arthrosis in the future. In addition, early correction of intra-articular displacement is easier than delayed correction. In these two cases, the joint surfaces were restored anatomically through the original fracture lines. However, it is open to discussion whether the remaining nine cases could be considered as nascent malunion and corrected before formation of full union and deformity. Jupiter and Ring, in their article comparing early and late correction, indicated that early correction was easier and would shorten the period of disability. [6]

In the 9 cases in our series with extra-articular deformity, none had less than 20° of dorsal angulation. We propose that, for young and active patients, early

Table 1. Mayo wrist scoring system.

Pain intensity	Functional status	Range of motion	Grip strength
No pain (25 points)	Returned to regular employment (25 points)	100% (25 points)	100% (25 points)
Mild occasional (20 points)	Restricted employment (20 points)	75-99% (15 points)	75-100% (15 points)
Moderate (15 points)	Able to work, but unemployed (15 points)	50-74% (10 points)	50-75% (10 points)
Severe (0 points)	Unable to work due to pain (0 points)	25-49% (5 points)	25-50% (5 points)
		0-24% (0 points)	0-25% (0 points)

For range of motion and grip strength the other wrist is compared and a % value is determined. The total points are evaluated as follows: 90-100 = excellent, 80-90 = good, 60-80 = satisfactory, 60 >= poor.

correction can be planned based on objective radiological criteria after informing the patient about the reconstructive procedure. Correction of nascent malunion has some advantages; anatomic correction is possible since the deformity is corrected after recreation of old fracture line, and the need for the use of structural bone graft is significantly decreased in cases in which the callus tissue can be used as a graft.^[11] Additionally, the use of fixed angled locking plates have decreased the need for corticocancellous grafting significantly.^[11] Additional bone graft was not used in four of the cases in our series, and iliac cancellous bone grafting was sufficient in 6 cases. Corticocancellous (structural) graft was used in only one case, thus reducing the morbidity that would result from harvesting of the graft from the iliac crest.^[12] Based on our experience and the current literature, we recommend the use of locking plates for fixation and the previous callus as graft.

The two cases in which union was achieved 10 and 16 weeks following osteotomy were heavy smokers. The role of smoking in the increase of complications and occurrence of delayed union and non-union following distal intervention have been demonstrated in literature.^[13-15] Henry,^[13] in a series where immediate mobilization was allowed following corrective osteotomy, reported that repeated grafting was needed to achieve union in two cases of heavy smokers. In our series, none of the cases required repeated grafting, possibly due to the difference in rehabilitation. It is recommended that the surgeon who undertakes such an operation should take the smoking habit of the patient into consideration.^[13-15]

Recreation of the original fracture line is not easy in the reconstruction of nascent malunion. The surgeon should properly concentrate on direct radiography during the recreation of fracture line and, if necessary, use fluoroscopy control during operation supported by 3D images of computerized tomography. Correction is relatively easier after the recreation of the fracture line. The restoration of anatomy is facilitated with the application of stable fixation, especially using volar fixed angle plates following the correction. We are of the opinion that brachioradialis tenotomy is necessary, particularly for the easy correction of radial inclination in cases over 10 weeks.

Mayo wrist score was an average of 82.5 and there were no poor results in terms of function. The interpretation of these results is that early correction of nascent radius malunion has good and acceptable functional outcomes.

Table 2. Demographic and clinical data of the patients.

Case no	Age/sex	Dorsal angulation pre/postop.	Ulnar variance pre/postop. (mm)	Radial inclination pre/postop.	Intra-articular fracture	Approach	Time to correction (weeks)	Complication	Occupation/hobby	Mayo wrist score	Grafting	Time to union (weeks)
1	29/M	32°/0°	+5/+2	10°/10°	No	Dorsal	12	None	Heavy worker	80	Cancellous	6
2	37/M	28°/-4°	+5/+1	12°/22°	No	Volar	12	None	Physical trainer	75	No	8
3	35/F	26°/-6°	+4/0	14°/22°	No	Volar	12	None	Architect	90	Cancellous	7
4	27/M	40°/5°	+9/0	7°/17°	No	Dorsal	15	None	Handball player	85	Cancellous	6
5	33/M	16°/-10°	+3/-2	10°/20°	Yes	Volar	14	None	Doctor	80	No	8
6	42/M	30°/0°	+5/-2	10°/18°	No	Volar	8	None	Plumber	75	No	8
7	34/M	34°/0°	+5/+1	5°/17°	No	Dorsal	12	None	Graphic designer	90	Cancellous	6
8	54/M	40°/10°	+6/+3	4°/22°	No	Dorsal	10	*RSD + delayed union	Plumber	75	Corticocancellous	16
9	32/M	26°/-7°	+5/+2	12°/20°	No	Volar	10	None	Bowling player	85	Cancellous	10
10	20/M	5°/-10°	+2/0	5°/24°	Yes	Volar	12	None	Climber	100	No	5
11	49/M	32°/-4°	+6/+1	10°/18°	No	Volar	15	None	Carpenter	70	Cancellous	8

*Reflex sympathetic dystrophy

Possible complications in the correction of distal radius malunion during the nascent stage include failure to achieve adequate correction and unstable fixation due to poor bone quality and infection. The expectations of the patients and the surgeon's aim should have complete conformity. Therefore, it is necessary for patients to be cooperative and have realistic expectations to achieve a successful outcome.^[11]

In conclusion, early correction of nascent malunion of distal radius fractures with objective radiological criteria in young and active patients shortens the recovery period and reduces the need for bone grafting, while allowing sufficient anatomic restoration along the original fracture line. Correction is relatively easier as soft tissue contractures are less but recreation of the original fracture line necessitates patience and control during surgery.

Conflicts of Interest: No conflicts declared.

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