

FRACTURES OF THE DISTAL RADIUS  
CURRENT CONCEPTS FOR TREATMENT

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The authors review the treatment of fractures of the distal radius, based on their experience and from data in the literature. The choice of a treatment for any given fracture must take into account first of all the stability of the fracture. The best results are achieved in stable fractures.

Only minimally displaced distal radius fractures can be treated functionally. However, a plaster cast for one week is indicated for the comfort of the patient. In displaced but stable fractures both closed reduction and percutaneous fixation are indicated. In case of closed reduction, the plaster cast should be applied for 5 to 6 weeks with an above-elbow cast for 3 weeks. Percutaneous fixation gives the best results in extra-articular fractures in younger patients. Because of its simplicity however, it should not be ignored in the elderly osteoporotic patients. In the authors' experience, both techniques were only used for extra-articular fractures. Good and excellent results were found in the closed reduction and plaster cast group in 74% of the patients; the Kapandji technique gave 75% good and excellent results. These results are in line with other findings which show that, for simple fracture types, the Kapandji technique and closed reduction seem to give similar results.

External fixation is widely used for intra-articular comminuted fractures. Dynamic external fixation does not show any advantage over static devices. Additional K-wires or bone grafting may be necessary. External fixation gives superior results to plate and screw fixation. Internal fixation should be reserved for fractures with ventral comminution or severe displacement with unacceptable reduction by closed or minimally invasive techniques.

**Keywords** : distal radius ; fracture ; external fixation ; internal fixation ; Kapandji pinning.

**Mots-clés** : radius distal ; fracture ; fixation externe ; ostéosynthèse ; Kapandji.

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Fractures of the distal radius have traditionally been discussed with reference to the eponyms Colles, Pouteau, Smith and Barton. However, it is more important today to determine the nature of the fracture and to describe the pathology involved, than to link diagnosis and treatment to a specific name. The type, direction and amount of displacement are the most important factors relating to treatment (20).

It is now generally accepted that for the ventral Barton fractures and for Smith fractures, internal fixation is indicated as these fractures are always articular and are associated with actual or potential subluxation or dislocation of the carpus with a distal fracture fragment (22).

Regarding Colles fracture however, there still is a lot of discussion. In 1940, Sir Reginald Watson Jones claimed that it must always be remembered that a Colles fracture, if left untreated, usually results in a fully functioning hand and forearm, albeit with displacement and some limitation in

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movement (68). It is important therefore to ensure that whatever treatment is given, the end result is better than leaving the fracture alone. In 1960, Sir John Charnley wrote: 'It is a fortunate thing that excellent functional results usually follow the common Colles' fracture, because disappointing results occasionally develop even in the most skilful hands' (9).

We now realize that many patients after distal radius fractures definitively do not enjoy perfect freedom in all wrist movements and that they are definitely not exempt from pain even after many months. In this paper discussion is directed to the current preferred methods of treatment based on the literature and on our own experience.

Various methods have been used historically to treat fractures of the distal radius. The first and by far the most frequently used method has been closed reduction and plaster cast immobilization. This treatment has been applied for many years, but it has recently received a lot of criticism, especially for the more complex fractures (14, 39, 64).

The treatment of distal radius fractures should start with recognition of the fracture pattern (55). The differentiation between a stable and an unstable fracture has to be made before treatment is started. The intra-articular involvement, the degree of displacement, the energy absorbed and soft tissue or other associated injuries should be evaluated.

Afterwards, the discussion can be made concerning the most adequate treatment for this fracture. The decision does not only depend on the fracture itself, but can also be influenced by the patient (age, reliability) as well as by surgeon-related factors such as skill and knowledge of the subject.

The treatment principles involve obtaining an anatomic reduction first and maintaining that reduction with appropriate methods of immobilization afterwards (4). The importance of anatomic reduction has been demonstrated by clinical studies of the natural history of incompletely reduced fractures as well as by laboratory assessment of forces and stress loading across the radiocarpal joint (65). Knirk and Jupiter, Bradway and associates and others have correlated the outcome after distal radius fractures with the initial and final fracture displacement (3, 6, 15, 31, 40). When part of the

joint articular surface was displaced more than 2 mm, radial shortening was greater than 5 mm, or dorsal angulation exceeded 20°, less than optimal results were seen. Posttraumatic arthritis was present at the radiocarpal and radioulnar joint in such patients. Wrist motion was decreased, grip strength was less than 50% of normal, and carpal subluxation with wrist instability was evident (2, 38). These clinical observations have been confirmed by laboratory studies which show that loss of radial length results in increased loads across the ulnocarpal joint and decreased force concentration across the radiocarpal joint. Every effort should be made to restore normal length, alignment and articular surface congruency of the distal radius.

It is clear that only minimally displaced fractures can be treated *functionally* (12, 37, 51). Dias *et al.* compared immediate mobilization versus plaster immobilization for 5 weeks. The early mobilization group had less soft tissue swelling and fewer contractures. No increase in malunion was seen (12). In the study by McAuliffe *et al.*, who compared extra-articular, noncomminuted fractures in elderly women with an average age of 72 years with 3 or 5 weeks plaster immobilization, a better grip strength was found in the group immobilized for 3 weeks. There was less pain, and the final anatomic result was no worse than in those immobilized for 5 weeks (37). In our own series, no differences were found between minimally displaced wrist fractures treated in a plaster cast for 1 or 3 weeks (61). Thus, if no displacement or comminution is present, an external splint is not necessary to prevent dislocation. However, a plaster cast for 1 week is indicated for the comfort of the patient. Displaced fractures need reduction as functional recovery depends upon anatomic reduction.

*Closed reduction and plaster cast* has since long been regarded as the routine treatment of distal radius fractures with dorsal angulation. Different techniques for the reduction have been recommended by Böhler (4). It comes down to application of traction and manipulation in palmar flexion and ulnar deviation. It has been noted by Wahlström and others that reduction of the fracture is usually easy to achieve, but there is a tendency to

redisplacement (32, 63, 64, 67). This can already occur during plaster application. The final outcome depends on the stability of the reduction and therefore on the type of fracture (32, 53, 56). If stable fractures are reduced, redisplacement is unlikely to occur and is not influenced by the position or whether above or below - elbow immobilization is used (16, 32, 47). For complex fractures however, the plaster cast results in up to more than 70% of malunion (41, 57). A number of authors therefore agree that plaster treatment should be reserved for stable fractures (5, 25, 31). In our own series of 50 patients with Frykman I, II, IV and VI fractures, treated with closed reduction and plaster cast, excellent and good results were obtained in 74% of the patients (62).

*Plaster cast immobilization with transfixing wires* was first described by Böhler, but is rarely used today (4). A pin is passed through the base of the metacarpals, and another one in either the radius or the ulna. Marsh and Teal reported good results with this technique (36). However, they only studied 20 patients and had 18 complications. Scheck reported 25% unsatisfactory results with this technique (52). We may conclude that transfixing K-wires probably give more stability, but have an unacceptable rate of complications (8, 20).

In an attempt to bridge the therapeutic gap between external fixators and plaster immobilization, *percutaneous pin fixation* has become a popular way to treat distal radius fractures. Several techniques have been recommended in the literature. Radial styloid pinning was initially mentioned by Lambotte in 1903. The two-pin intrafocal technique was first described by Kapandji in 1976 (28). This is probably the most frequently used technique of percutaneous K-wire fixation of distal radius fractures. It is the only technique where K-wires are used through the dorsal fracture line. Many reports have described good results (13, 29, 33). Kapandji changed his technique in 1987 by adding a second pin on the dorso-ulnar side to stabilize the ulnar fragment of the distal radius. Loss of reduction, extensor tendon ruptures, reflex sympathetic dystrophy and early pin removal due to infection have all been described (10, 19, 21, 29). It

is however the only percutaneous technique with a large number of reports in the literature. Contraindications as mentioned by Greatting and Bischoff should include: volar cortical comminution, significant intra-articular displacement and impossibility to obtain anatomical reduction by closed means (19). Reduction is more difficult to maintain in the elderly patient, which results in a higher percentage of poor or fair results (42). We may therefore conclude that the percutaneous technique should be reserved for extra-articular fractures with or without dorsal comminution in younger patients (10, 42, 56).

In our experience, excellent and good results were obtained in 75% of the 48 patients with Frykman I, II, IV and VI fractures treated with Kapandji pinning (62). However, no statistically significant difference in Cooney score could be found with the closed reduction and plaster cast group. The incidence of reflex sympathetic dystrophy was equal in both groups, as was the incidence of nerve injury or tendon rupture.

*Fixation with biodegradable rods* is very popular in Scandinavian countries, but is not often used in the rest of Europe. Hoffmann *et al.* reported 9 out of 34 patients with foreign body reactions (24). The only advantage of these rods is that they do not need to be removed as they are biodegradable. However, ordinary K-wires are removed on an outpatient basis without any additional use of anesthetics. Therefore, the use of biodegradable fixation rods in the treatment of distal radius fractures is often of doubtful interest (7).

*External fixation* is probably the most popular treatment of complex inherently unstable distal radius fractures. A need for surgical intervention in these fracture types is mentioned by many authors (23, 39, 45). In the Frykman classification these fracture types are usually type VII and VIII, in which comminution and displacement are present in addition to intra-articular involvement (17). Melone has called attention to intra-articular fractures as four-part fractures of increasing severity through four types (40). Primary external fixation should be considered for universal classification

fracture types II, IVA and IVB (35, 54). Secondary external fixation is indicated when there is loss of reduction after cast immobilization. The external fixator has shown to be effective in the surgical management of unstable intra-articular fractures, but has also been linked with an unacceptable rate of complications in some series (63). However, a lot of complications can be avoided using a good surgical technique. Most studies report around 90% excellent or good results. D'Anca *et al.* showed 78% excellent and 60% good results in a series of 87 patients where 73% were Frykman VII and VIII fractures (11). Sometimes, additional K-wire fixation and bone grafting may be necessary to achieve or to maintain fixation.

The specific method of external fixation is less important in the treatment of these fractures than adhering to the principle of maintaining reduction with fixed tractions (18, 26, 43, 48, 49, 50, 56). Simpson *et al.* studied different fixation devices in a biomechanical study. They concluded that the small Hoffman external fixator was the most stable, but it may cause problems in elderly patients because of its weight (58). Sommerkamp *et al.* concluded that there was no place for dynamic external fixation, as the mobility and the anatomical reduction were better in patients treated with a static fixator (59).

The time for fixator removal is a point of debate. Suso *et al.* (63) left the fixator on for 10 weeks, Poirier (46) for 6 to 8 weeks. So, for intra-articular comminuted fractures which can be reduced by means of ligamentotaxis, a static external fixation device for 6 weeks is a suitable treatment.

In our series, patients with complex fractures Frykman VII and VIII were alternatively treated with external or internal fixation with a ventral plate (60). Following evaluation after one year, however, internal fixation was abandoned because of the high incidence of median nerve lesions (28% in the internal fixation group compared to 5% in the external fixator group). Twenty-five patients had plate and screw fixation, while 81 had an external fixator. As to the subjective evaluation, excellent and good results in the external fixation group totaled 75% compared to 58% in the plate and screw fixation group. Results of external fixa-

tion were significantly better than those of internal fixation. The average Cooney score for Frykman VII and VIII treated with a plate fixation was 67.2% compared to 74.8% for external fixation in the same fracture type ( $p = 0.002$ ).

Plate fixation does not seem to restore and maintain volar tilt. The same is true for the radial angle. Ventral plate fixation does automatically correct dorsal angulation. This can be explained by the presence of dorsal comminution (fig. 1). It would therefore be more logical to put a plate on the dorsal aspect, but the irregularities of its surface and the presence of extensor tendons make this difficult. As external fixation shows comparable results, this is probably a better solution.

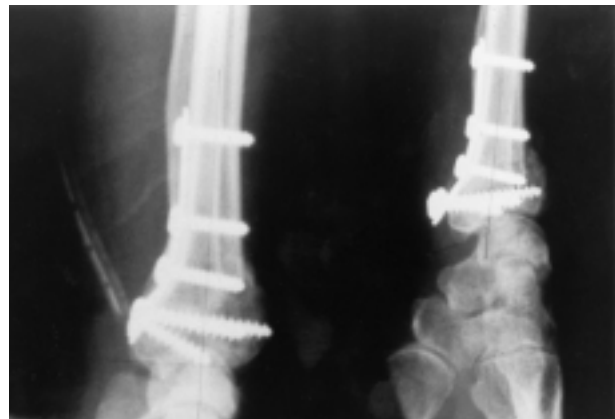


Fig. 1. — Redislocation after ventral plate fixation

*Internal fixation* should be reserved for fractures with ventral comminution or severe displacement with unacceptable reduction by closed or minimally invasive techniques. In some cases however, it is also used for dorsally displaced intra-articular comminuted fractures. Perfect anatomical restoration is not always possible by closed means. Several factors may compromise the success of closed reduction or limited open reduction techniques. Volar comminution or failure to restore a volar cortical buttress will lead to subsequent collapse. Comminution at the level of the distal radioulnar joint is sometimes difficult to reduce by closed means (27). Sometimes dorsal and volar fragments can be pulled out to length, but malrotation with respect to each other may persist. In these cases, open

reduction and fixation of the fragments, either with plate and screws or pins may be necessary. Additional fixation might be advisable (22, 27).

There is no ideal implant for the distal radius. Complications are described in the series of Vichard *et al.* (66). Nearly 50% of patients had transient nerve problems, 9% had problems with hypertrophic scars and 16% developed reflex sympathetic dystrophy. Tendon erosions are also possible. Although the biomechanical features of the fractures should encourage the use of dorsal plates, problems with the extensor tendons have also been described. The dorsal surface of the radius is very irregular in shape, making the appropriate plate fixation more difficult. Plate fixation should therefore be reserved for fractures with ventral comminution or severe displacement where an acceptable reduction of the articular surface cannot be achieved by closed means or where malalignment persists after closed attempts at reduction (6, 56, 65).

A few authors have described the use of *bone grafts* in the treatment of distal radius fractures. Laulan advised the use of iliac crest grafts in severe defects of the radial metaphysis (32). Leung *et al.* reported in 1989 a study with the use of an external fixator for 3 weeks and primary cancellous bone grafting as a standard method of treatment for comminuted fractures of the distal radius (34). They reported 80% good results. This percentage can also be reached by external fixation alone as was demonstrated by Schuind *et al.* (54).

As an alternative to bone grafting, Trawley reported the use of bone cement in distal radius fractures in 1970. Only a few papers could be found in the literature concerning the use of this technique (44, 53). A more recent publication of Kiyoshige reported good results, but only 10 patients were included in this study. He recommended the use of bone cement for bone loss at the distal radius in patients over 75 years of age (30).

### CONCLUSIONS

Only minimally displaced distal radius fractures can be treated functionally. However, a plaster cast for one week is indicated for the comfort of the patient.

In displaced but stable fractures both closed reduction and percutaneous fixation are indicated. In case of closed reduction, the plaster cast should be applied for 5 to 6 weeks with an above-elbow cast for 3 weeks. Percutaneous fixation gives the best results in extra-articular fractures in younger patients. Because of its simplicity however, it should not be disregarded in elderly osteoporotic patients. In the authors' experience, both techniques were only used for extra-articular fractures. Good and excellent results were found in the closed reduction and plaster cast group in 74% of the patients; the Kapandji technique gave 75% good and excellent results. These results are in line with those from other studies showing that for the simple fracture types, the Kapandji technique and closed reduction seem to give similar results.

External fixation is widely used for intra-articular comminuted fractures. Dynamic external fixation does not show any advantage over static devices. Additional K-wires or bone grafting may be necessary. External fixation gives superior results to plate and screw fixation. Internal fixation should be reserved for fractures with ventral comminution or severe displacement with unacceptable reduction by closed or minimally invasive techniques.

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## SAMENVATTING

*P. L. O. BROOS, I. A. M. FOUREAU, D. V. C. STOFFELEN. Distale radius fracturen ; overzicht van de huidige opvattingen.*

De auteurs overlopen de indicatie van de verschillende behandelingsmogelijkheden bij fracturen van de distale radius aan de hand van de literatuur en hun eigen ervaring. De keuze van behandeling wordt vooral bepaald door de stabiliteit van de breuk.

De beste resultaten in de behandeling van polsfracturen worden bekomen bij stabiele letsels. Functionele behandeling is mogelijk alleen bij minimaal verplaatste distale radiusfracturen. Voor het comfort van de patiënt is een korte immobilisatie (1 week) aan te bevelen. Verplaatste stabiele fracturen komen in aanmerking voor gesloten reductie en percutane pinning, gevolgd door ingipsen voor 5 à 6 weken waarvan 3 weken boven de elleboog. Percutane pinning geeft de beste resultaten bij extra-

articulaire fractures bij jongere patiënten. Maar omwille van zijn eenvoud is deze techniek ook te overwegen bij oudere osteoporotische patiënten. De auteurs pasten beide technieken slechts toe bij extra-articulare breuken. De resultaten waren goed tot excellent in 74% van de gevallen (tegen 75% met de Kapandji-techniek). Onze resultaten bevestigen de vaststellingen van Greeting, Bishop en Altissimi: bij eenvoudige fractuurtypes geven de Kapandji-techniek en de gesloten reductie gelijkaardige resultaten (1, 19). Voor intra-articulaire comminutieve fractures is het gebruik van uitwendige fixatie zeer verspreid. Dynamische fixatie lijkt geen voordelen te bieden boven statische toestellen. Wel kunnen bijkomende Kirchners en botenten nodig zijn. Uitwendige fixatie geeft betere resultaten dan plaat fixatie. Inwendige fixatie is te reserveren voor breuken met ventrale comminutie en sterke verplaatsing, niet te corrigeren met gesloten of minimaal-invasieve technieken.

### RÉSUMÉ

*P. L. O. BROOS, I. A. M. FOURNEAU, D. V. C. STOFFELEN. Conception actuelle du traitement des fractures de l'extrémité distale du radius.*

Les auteurs passent en revue les indications des différents modes de traitement des fractures du radius distal, en se basant sur leur expérience personnelle et sur les données de la littérature. Le choix thérapeutique dépend avant tout de la stabilité de la fracture.

Les meilleurs résultats sont obtenus dans le cas des fractures stables. Le traitement fonctionnel n'est légitime que pour des fractures à déplacement minime; une immobilisation de courte durée (une semaine) est cependant conseillée pour assurer le confort du patient. Les fractures déplacées mais stables sont des indications pour une réduction à foyer fermé suivie d'embrochage percutané. Ce traitement doit être suivi d'une immobilisation plâtrée de 5 à 6 semaines, dont les trois premières dans un plâtre prenant le coude. Cette technique donne ses meilleurs résultats dans les fractures extra-articulaires chez des sujets jeunes. En raison de sa simplicité, elle peut certainement être envisagée aussi chez des patients plus âgés, ostéoporotiques. Les auteurs n'ont utilisé ces deux techniques que dans des cas de fracture extra-articulaire. Ils ont obtenu des résultats bons ou excellents dans 74% des cas, contre 75% avec la technique de Kapandji. Cette observation rejoint celle d'autres auteurs, qui ont obtenu des résultats identiques dans les fractures simples avec la technique de Kapandji et la réduction à foyer fermé. L'utilisation du fixateur externe s'est généralisée pour les fractures intra-articulaires comminutives. L'utilisation d'une fixation externe dynamique ne semble pas apporter d'avantages par rapport au fixateur statique. Dans certains cas cette technique doit être associée avec un embrochage complémentaire.

La fixation externe donne de meilleurs résultats que l'ostéosynthèse par plaque. Celle-ci doit être réservée aux fractures avec comminution antérieure et déplacement important, qui ne peuvent être traitées correctement par des techniques percutanées ou mini-invasives.