Refracture rate after plate removal from the radial metaphysis

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Objectives: To document the refracture rate after removal of internal fixation at the metaphyseal region of the distal radius and to compare this rate to that associated with diaphyseal plate removal reported in the literature. **Design:** A chart review with telephone follow-up. **Setting:** Three tertiary care hospitals (in Ottawa, Burlington, Vt., and London, Ont.). **Patients:** Fifty-three patients (54 radii) underwent elective removal of internal fixation of the distal radius after distal metaphyseal procedures. The mean follow-up was 46.8 months. **Main outcome measure:** The refracture rate. **Results:** No refractures were reported after plate removal, and the overall complication rate was minimal. **Conclusions:** The refracture rate at the metaphysis of the radius after plate removal is lower than the rate after diaphyseal plate removal reported in the literature.

Objectifs : Documenter le taux de fractures itératives après l'enlèvement de la fixation interne à la région métaphysaire de la partie distale du radius et comparer ce taux à celui qu'on associe à l'enlèvement de la plaque diaphysaire signalé dans les écrits. **Conception :** Étude de dossiers et suivi par téléphone. **Contexte :** Trois hôpitaux de soins tertiaires (à Ottawa, Burlington [Vermont] et London [Ont.]). **Patients :** Cinquante-trois patients (54 radius) qui ont subi une intervention élective visant à enlever la fixation interne à la partie distale du radius après une intervention à la région métaphysaire distale. Le suivi moyen s'est établi à 46,8 mois. **Principale mesure de résultats :** Le taux de fractures itératives. **Résultats :** On n'a signalé aucune fracture itérative après l'enlèvement de la plaque et le taux global de complications a été minime. **Conclusions :** Le taux de fracture itérative à la métaphyse du radius après enlèvement de la plaque est plus faible que le taux signalé dans les écrits après enlèvement de la plaque diaphysaire.

Open reduction with internal fixation of distal radial fractures is being practised with increased frequency. Although cast immobilization and external fixation (with or without open reduction) with Kirshner-wire fixation is more common, in selected cases, insertion of a plate and screw fixation is a more favourable treatment option.[1] For example, in cases of malunion of distal radial fractures and in Kienböck's disease, where corrective osteotomy is required, internal fixation is the usual practice.

Although there is much published data regarding the refracture rate after removal of plates for diaphyseal fractures of the forearm,[2–9] there is no published information documenting the incidence of metaphyseal refracture after plate removal. Therefore, the primary purpose of this study was to determine the incidence of refracture after the removal of such implants. A secondary purpose was to identify some of the factors that are associated with complications after plate removal.

Methods

Between January 1980 and June 1995, The Ottawa Hospital — General Campus, in Ottawa, The Medical Center Hospitals of Vermont in

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Burlington, Vt., and the University Hospital, St. Joseph's Campus, University of Western Ontario in London, Ont., treated 500 patients with radial fractures or osteotomies. Of these, 53 patients (31 men, 22 women) underwent distal metaphyseal procedures (located in the area overlying trabecular bone) and elective removal of the internal fixation. The mean (and standard deviation [SD]) age of the patients was 34.7 (14.5) years.

A chart review revealed that 28 patients underwent emergency internal fixation after trauma, 21 patients underwent internal fixation after corrective osteotomy for malunion and another 4 patients had internal fixation after radial metaphyseal shortening for Kienböck's disease. One patient had bilateral osteotomies for Kienböck's disease, resulting in 54 cases of plate removal. All patients with a follow-up time of less than 6 months were contacted by telephone to ascertain fracture status and complications related to removal of the plate.

Of the 28 fractures resulting from trauma and requiring emergency plate insertion, 3 were compound fractures. Satisfactory reduction was obtained in all 28 fractures. Eighteen patients had associated musculoskeletal injuries. Forty-nine of the fractures and osteotomies were in the metaphysis and 5 were at the metaphyseal–diaphyseal junction, although healing was through trabecular bone. The volar approach to plate removal was used in 19 cases and the dorsal approach in the remaining 35 cases. Autogenous bone grafting was used in 22 cases, and in 1 case supplemental cadaveric bone grafting was required. Antibiotics were given prophylactically to 37 patients preoperatively and to all patients postoperatively. Buttress plates were used in 81% (44 of 54) of the cases.

The plate was removed only after the bone was judged to be clinically and radiographically healed. In all cases, the plates were removed because they were believed to be the cause of local symptoms. The average interval between internal fixation and plate removal was 13.6 months (range from 2.5–47 mo). All plates, with the exception of 1, were removed through surgical day care or single-day admission. Two patients had 2 plates removed. At the time of removal, 11 received antibiotics. Eighteen patients had brief postremoval immobilization (Table 1).

The rate of refracture after metaphyseal plate removal was compared to that in a literature review of the incidence of refracture after diaphyseal plate removal. To facilitate this comparison, the combined diaphyseal refracture rates and their 95% confidence intervals (CIs) were estimated using the inverse variance weighted method, wherein each study rate is weighted according to its precision. The combined bone refracture rates were calculated, with the assumption that bone sites refracture independently within patients. Assuming a binomial distribution with the combined rate, the probability of observing no fractures after metaphyseal plate removal was derived.

Results

At a mean (and SD) follow-up of 46.8 (5.8) months (range from 2.0–160 mo, 95% CI 35.0–58.6 mo) no refractures had occurred in the region of the previous fracture or osteotomy. Three patients with a follow-up of less than 6 months could not be contacted by telephone, but information gathered from the chart review for these patients is included in the data set.

Nearly 16% (3 of 19) of the volar metaphyseal procedures were associated with carpal tunnel syndrome, whereas none (of 35) of the dorsal approaches were.

Four patients (7%) experienced 6 complications after plate removal: 1 had transient carpal tunnel syndrome that resolved, and 2 others suffered carpal tunnel syndrome that required carpal tunnel release; 1 patient had reflex sympathetic dystrophy. There were no infections.

A literature review of the incidence of refracture after diaphyseal plate removal showed that these rates ranged from 1.9% to 30.4% (Table 2).[2–9] The combined diaphyseal refracture rates and their 95% CIs, estimated using the inverse variance weighted method, indicated that the refracture rate reported in the literature for diaphyseal plate removal was

Table 1

Immobilization After Plate Removal From the Distal Radial Metaphysis in 18 Patients

Immobilization	No. of patients
Futuro splint	3
Volar splint, 5 d–2 wk	6
Short arm cast, <2 wk	3
Short arm cast, 2 wk–2 mo	4
Long arm cast	2

Table 2

Cumulative Refracture Rate After Removal of Diaphyseal Plates

Study	No. of patients / total no. of patients	%	No. of bones / total no. of bones	%
Labosky et al, 1990[2]	1/51	1.9	2/80	2.5
Rumball and Finnegan, 1990[3]	4/63	6.3	6/92	6.5
Hidaka and Gustilo, 1984[4]	7/23	30.4	8/32	25.0
Rosson and Shearer, 1991[5]	4/51	7.8	N/A	N/A
Deluca et al, 1988[6]	7/37	18.9	9/62	14.5
Langkamer and Ackroyd, 1990[7]	2/55	3.6	2/81	2.5
Bednar and Grandwilewski, 1992[8]	4/74	5.4	6/111	5.4
Teipner and Mast, 1980[9]	N/A	N/A	1/62	9.6
Total/relative rate	29/354	8.2	40/527	7.6

5% (95% CI 2.8%–7.2%). Thus, the probability of observing no refractures in the study sample based purely on chance is only 7%.

Discussion

The primary purpose of the present study was to determine the incidence of refracture after the removal of plates from the metaphyseal region of the distal radius. A secondary objective was to compare this rate to that of diaphyseal plate removal reported in the literature. These results provide preliminary evidence for the generalized suggestion that the refracture rate following metaphyseal plate removal is lower than after diaphyseal plate removal.

The observed difference in refracture rates between metaphyseal (cancellous) and diaphyseal (cortical) regions is likely related to the mechanism of healing of each type of bone[10,11] and its response to the presence of rigid fixation implants. It has been documented that diaphyseal bone that is not rigidly fixed will go through a process of periosteal healing involving callus formation that will respond differently to torsional stresses at different stages of healing.[10,12] However, when rigidly fixed, as in compression plating, haversian healing is the main process. Several studies have reported that cortical bone also undergoes cancellous bone transformation, that the size of the medullary cavity increases and that the presence of a plate may prevent normal remodelling and healing by absorbing the stress around the fracture site.[13–18] Stress shielding interferes with the return to normal strength of the healed diaphyseal bone, particularly evident after plate removal. Conversely, metaphyseal (cancellous) bone heals by new bone apposition on existing trabeculae.[11] It usually does not rely on periosteal activity and is, therefore, mostly an intramedullary process.[11,19] Thus, it may respond differently to the load sharing by the plate, since stresses at the metaphysis are those of compression, as opposed to the diaphysis where torsional or bending forces are present. A plate may interfere less with compression forces. Moreover, fracture healing takes place around and between the trabeculae[11] and is likely not altered by the presence of the implant. Therefore, the healed metaphysis may be able to withstand close to normal physiologic stresses after plate removal, a contention supported in this study by the zero refracture rate. The results of this study suggest a number of clinically relevant issues, such as whether mobilization is safer among patients who undergo plate removal from the metaphyseal as compared with the diaphyseal region of the distal radius.

Further, it is reasonable to suggest that if a problem such as Kienböck's disease can be treated by osteotomy of either metaphyseal or diaphyseal bone, then a full consideration of the early and later aspects of treatment (i.e., after plate removal) may be important in the initial planning. There are 5 joint-levelling procedures that are accepted treatment methods for early stages of Kienböck's disease. The approach may be either a radial metaphyseal shortening or diaphyseal shortening, performed through either a dorsal or volar approach, or ulnar diaphyseal lengthening. Each of these approaches is associated with a unique anatomy and possible complications. If joint levelling can be achieved with any of the 5 approaches, the approach associated with a lower rate of complications and a lower refracture rate after plate removal should be chosen. Our study showed the increased incidence of carpal tunnel syndrome with volar metaphyseal procedures and the absence of this complication when a dorsal approach was used. Tenosynovitis and rupture of the flexor pollicus longus tendon also tend to occur with the volar approach.[20] The dorsal metaphyseal approach is also associated with extensor tendon adhesions. The ulnar lengthening procedure is associated with gap formation requiring grafting and with a 14% rate of delayed union and nonunion.[21] The 3 diaphyseal joint-levelling procedures for the treatment of Kienböck's disease may be associated with a clinically significant refracture rate after plate removal.[2–9] Further research is needed to investigate the hypothesis that an osteotomy performed in the metaphyseal region as opposed to the diaphyseal region may be the preferable treatment option for Kienböck's disease.

In conclusion, in our study there were no refractures after plate removal from the metaphyseal region of the distal radius. When these findings were compared with those of diaphyseal plate removal in the literature, the findings suggested that the refracture rate is lower after metaphyseal plate removal than diaphyseal plate removal.

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