REFRACTURE AFTER THE REMOVAL OF PLATES FROM THE FOREARM

AN AVOIDABLE COMPLICATION

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The incidence of refracture following the removal of screws and plates from the diaphyses of 115 forearm bones in 80 patients has been studied. Refracture occurred in four adult patients as a result of minimal trauma, in two patients at the original fracture site after premature plate removal, at the site of a countersunk interfragmentary screw in one and at the original fracture site in another who had required three operative procedures to achieve 'union'. It is suggested that refracture could have been avoided in at least two of these patients. If the 3.5 mm plating system has been used, the incidence of refracture should be minimal.

The use of internal fixation plates is a well-established method of fracture management. The technique is controversial in other bones but its application to displaced diaphyseal fractures of the forearm has been almost universal. The theoretical adverse effect of rigid plates on bone and the desire to avoid leaving a foreign body implanted indefinitely has led to the practice of removing plates when fractures have united (Ulthoff and Finnegam 1983). The AO/ASIF have issued guidelines for the timing of plate removal and suggest that the incidence of refracture should not exceed 1.5% (Müller et al 1979). However, more recent reports have suggested that the incidence of refracture after removal of plates from the forearm bones can be as great as 20% (Hidaka and Gustilo 1984; DeLuca, Ruwe and Lindsey 1987). One standard text on the management of fractures recommends a six-week period of cast immobilisation in the light of a 20% refracture rate (Harkess, Ramsey and Ahmadi 1984).

Hidaka and Gustilo (1984) reported refracture in six out of 23 patients following removal of forearm plates, despite six weeks cast immobilisation, and concluded that plates should not be removed before 12 months. In 1987 DeLuca et al attempted a more detailed analysis of factors predisposing to refracture among 37 patients, seven of whom refractured. It was concluded that high-energy injuries, compound wounds, failure to achieve adequate compression at surgery and failure to graft bone about comminuted fractures, all predisposed to refracture. It was also suggested that patients undergoing primary surgery immediately after injury were more likely to refracture than those in whom surgery was delayed for a week or more.

Our policy has been to treat displaced diaphyseal fractures of the forearm bones in adults by open reduction and internal fixation. This method has also been used in children in whom satisfactory reduction could not be achieved or maintained by closed methods. In the majority of cases the plates and screws have been removed and while there has been no strict policy relating to the timing of plate removal, in general, the AO/ASIF recommendations have been followed (Müller et al 1979). Postoperative splintage has not been used as a routine. In this study the incidence of refracture has been reappraised.

PATIENTS AND METHODS

All patients who had had internal fixation plates removed from the diaphyses of the radius and ulna between 1980 and 1987 were identified from the operating department records. The notes of these patients were then examined and all relevant information recorded. In addition a questionnaire was sent to all patients or their parents in an attempt to identify any cases of refracture which might have been treated at another hospital.
The site of any fracture and the degree of trauma involved were noted. The results were analysed in an attempt to identify factors predisposing to refracture and to determine whether or not the complication could have been anticipated and therefore avoided.

Using a chi-squared test with Yates' correction for small numbers, the incidence of refracture among those patients who had plates removed before 12 months had elapsed was compared with those in whom the plates were retained for more than 12 months. Similarly the incidence of refracture among those in whom the plates were removed before 18 months had elapsed was compared with those in whom the plates were retained in position for longer.

RESULTS
A total of 115 plates had been removed from the forearm bones of 80 patients. There was a natural division of these patients into two groups according to skeletal maturity.

In children, 43 plates had been removed from the forearm bones of 29 patients. Nineteen were male and 10 female with a mean age of 12 years at fracture (range 5 to 15). Thirty-five of the plates were one-third-tubular and seven were dynamic compression plates. Only one fracture resulted from a road traffic accident, none was compound and the mean interval between injury and internal fixation was seven days. The mean interval between internal fixation and plate removal was 13 months (range 3 to 39). There was no case of refracture in this group of patients.

In adults, 73 plates had been removed from 51 forearms. There was a predominance of male patients and 39 had sustained the injury in a road traffic accident. Despite this, only four instances of open fracture were recorded. The majority of fractures had been treated by open reduction and internal fixation at an early stage, 76% within 24 hours of injury. Thirty-six one-third-tubular plates and 29 dynamic compression plates had been used although recently compression plates were used more often. Bone graft had been added at the initial operation in only four patients. The mean interval between internal fixation and plate removal was 26 months (range 3 to 98). In two patients the plates were removed after three months due to infection. It was recognised that these fractures were not united; plaster cast protection was used and the fractures united uneventfully.

There were four cases of refracture in this group of patients, all occurring with insignificant trauma within one month of surgery. In three of these patients refracture occurred at the original fracture site. In two, the plates had been removed 11 months after internal fixation. In the third, refracture occurred one month after plate removal, 36 months after injury. However, this patient had required three operative procedures to achieve 'union'. In the fourth case refracture occurred at the site of a substantial defect produced by removal of a countersunk interfragmentary screw at 10 months (Figs 1 and 2).

The questionnaire produced 47 replies but revealed no further instance of refracture.

The AO/ASIF have recommended that plates should not be removed from the forearm before 18 months have elapsed (Müller et al. 1979), and in 1984 Hidaka and Gustilo concluded that plates should never be removed within 12 months of surgery. Application of a chi-squared test (with Yates' correction), to the results of this study revealed that refracture was significantly more common (p < 0.01) among those patients having plates removed within 12 months compared with those in whom the plates remained for longer (Table 1). The increased incidence of refracture among those having plates

![Figure 1 - Radiograph of plated fracture to show site of a countersunk interfragmentary screw.](image1)

![Figure 2 - Radiograph showing that refracture occurred through the screw hole rather than the original fracture site.](image2)

**Table 1.** Incidence of refracture, among patients whose plates were removed, excluding two patients who had plates removed early for infection

<table>
<thead>
<tr>
<th>Interval between fixation and plate removal (mth)</th>
<th>Number Refractured</th>
<th>Number Intact</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;12</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>&gt;12</td>
<td>1</td>
<td>42</td>
</tr>
</tbody>
</table>

chi-squared = 10.2, p < 0.01
removed before 18 months had elapsed, compared with those in whom the plates remained for longer, did not achieve statistical significance.

Interfragmentary screws outside the plate had been used in only five patients. All were removed and in one patient the defect acted as a focus for refracture. In contrast to this all the patients in the study had multiple 3.5 mm screw hole defects, and none of these acted as a focus for refracture.

DISCUSSION

The division of the patients into two groups allows a more realistic appraisal of the incidence of refracture. Immature bone is known to heal well and this has been borne out by this study. Despite relatively early plate removal there were no refractures among the 29 children. The four cases of refracture seen among the 51 patients over the age of 16 years represents a refracture rate considerably lower than those reported by Hidaka and Gustilo (1984) and DeLuca et al (1987) but remains higher than that reported by the AO/ASIF.

In this study all cases of refracture were precipitated by minimal trauma. Three refractures occurred at the original fracture site. In two of these patients the plates had been removed before the recommended 18 months had elapsed and the third had required three operative procedures to achieve 'union'. This suggests that fracture consolidation was inadequate and that in at least the two otherwise uncomplicated cases, refracture could have been anticipated, and avoided by longer delay. The wisdom of removing the plate from the third patient in whom union had been so difficult to achieve could be questioned.

In 1989 Chapman, Gordon and Zissimos observed refracture through residual screw holes following removal of 4.5 mm screws from the forearm but not after the removal of 3.5 mm screws. They further suggested that use of the 4.5 mm system contributed to the high incidence of refracture in the Hidaka and Gustilo series. The observation in this study, that the only case of refracture through a residual screw hole occurred at the site of a hole that had been enlarged with a countersink, supports the view that, while 3.5 mm defects must weaken bone (Müller et al 1979), defects of this size rarely result in refracture.

In Hidaka and Gustilo's series two cases of refracture occurred within the six-week period of cast immobilisation. Refracture occurred rather later in that series than in ours suggesting that postoperative immobilisation may act to delay rather than prevent refracture. Certainly the lack of postoperative immobilisation in our series did not lead to an increased incidence of refracture.

We recognise that the complications of plate removal in the forearm are not confined to refracture and we are not advocating the widespread removal of asymptomatic plates. Nevertheless, we believe that patients with symptoms are entitled to have their plates, usually those on the ulna, removed. It is suggested that the incidence of refracture following the removal of a 'small fragment' plate should be minimal provided it is not removed prematurely and provided the residual defects do not exceed 3.5 mm diameter. Despite the observation that only those patients having plates removed within 12 months were significantly more likely to refracture, we believe that early plate removal is associated with both inadequate fracture consolidation and abnormal bone structure secondary to the effects of plating (Rosson, Petley and Shearer 1991). If both of these are to be avoided plates should remain on the forearm for at least 18 months as recommended by the AO/ASIF (Müller et al 1979).

We are grateful to the orthopaedic surgeons in Southampton, Mr A. Fitzgerald, Mr R. Jackson, Mr J. Robertson, Mr J. Wilkinson and Mr S. Wood, for allowing us to study their patients.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

REFERENCES


