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FRACTURES OF THE DISTAL END OF THE FOREARM

Radiological Evaluation of the Incidence of Displacement After Treatment By Circular High Cast as Compared with Circular Low Cast

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Ever since Colles' fracture was first described (Colles 1814), it has posed therapeutic problems, and many different methods of treatment have been applied (Erin Madsen 1949, Böhler 1953, Hølund 1957, Bauer 1960, Castaing 1964, Watson Jones 1965). This indicates that none of the methods has afforded satisfactory results. The most common method is reduction followed by immobilization in a plaster cast, either in the form of a dorsal cast or a circular forearm cast. Regardless of the therapeutic method, however, a varying number of complications occur, such as secondary displacement, reflex dystrophy or rupture of extensor tendons (Nissen-Lie 1939, Bauer 1960, Djørup 1962, Castaing 1964).

It is not surprising that the types of fracture which most often get displaced are fractures which primarily show marked displacement as well as comminuted and/or intra-articular fractures which are most unstable. These fractures make up the greater part of all fractures in the distal end of the forearm, and as the therapeutic results are on the whole poor, attempts have been made at improving them by various means (Hughston 1962). The most reasonable way of doing so is by immobilizing the elbow. It is logical to expect better results from this method of dressing, as immobilization of the two joints closest to a fracture is a golden rule in the management of practically all fractures treated in a plaster cast.

The incidence of secondary displacement of the distal fragment of the most difficult fractures, *viz.* types 4 and 5 according to the Nissen-Lie classification, has been reported to have been reduced from 59 to 11 per cent by application of circular high plaster cast when the swelling has subsided (Erin Madsen 1949). Castaing (1964), more than most other surgeons, advocates osteosynthesis, but he stresses the importance of a meticulous study of the X-ray films before deciding upon osteosynthesis and warns against its systematic use. Watson Jones (1955) and Böhler (1953) apply a circular forearm cast after careful reduction.

The object of the present study was to ascertain whether immobilization of the elbow reduces the incidence of displacement of the distal fragment, that is, whether type of fracture is best immobilized by immobilizing both adjacent joints (Nissen-Lie 1939, Ingebrigtsen 1946, Erin Madsen 1949). Another object was to investigate the time at which the displacement occurred, which types of fracture most often showed displacement, and whether the incidence of displacement differed after the two methods of treatment.

Studying the functional result was outside the scope of the present study. In a follow-up of 2100 Colles fractures, Bacorn & Kurtzke (1953) found a good anatomical result to be a presupposition for achieving a good functional result.

MATERIAL AND METHODS

The fractures were grouped into the 7 types set up by Nissen-Lie (1939) and are illustrated in Figure 1. Each type was analysed separately.

Type 1: A fracture at the junction of the shaft and distal extremity of the radius, i.e. somewhat more proximal than the most common fractures. Frequently it is associated with a fracture of the ulna. This type occurs only in children aged 1–15 years and is often of the green-stick type.

Type 2: Slipping of the epiphysis with dorsal displacement, often with a dorsally avulsed triangular fragment of the radius. Occurs in the age range 10–20 years.

Type 3: Fracture through the distal end of the radius with negligible displacement. The fracture line runs transversely through the radius, about 1 cm proximal to the articular surface and is often visible only as an irregularity on the dorsal aspect. Occurs in adults of all ages.

Type 4: The typical radial fracture with dorsal and radial displacement. Frequently this fracture is comminuted with small fragments dorsally.

Type 5: The typical radial fracture with splintering of the distal fragment. This fracture is always intra-articular, T- or Y-shaped. Common in elderly and aged persons.

Type 6: Isolated fracture through the styloid process of the radius. Very rarely displaced. Seen most commonly in men aged 20–50.

Type 7: All fractures with volar displacement, i.e. Smith's fracture, as well as epiphysiolysis with volar displacement.

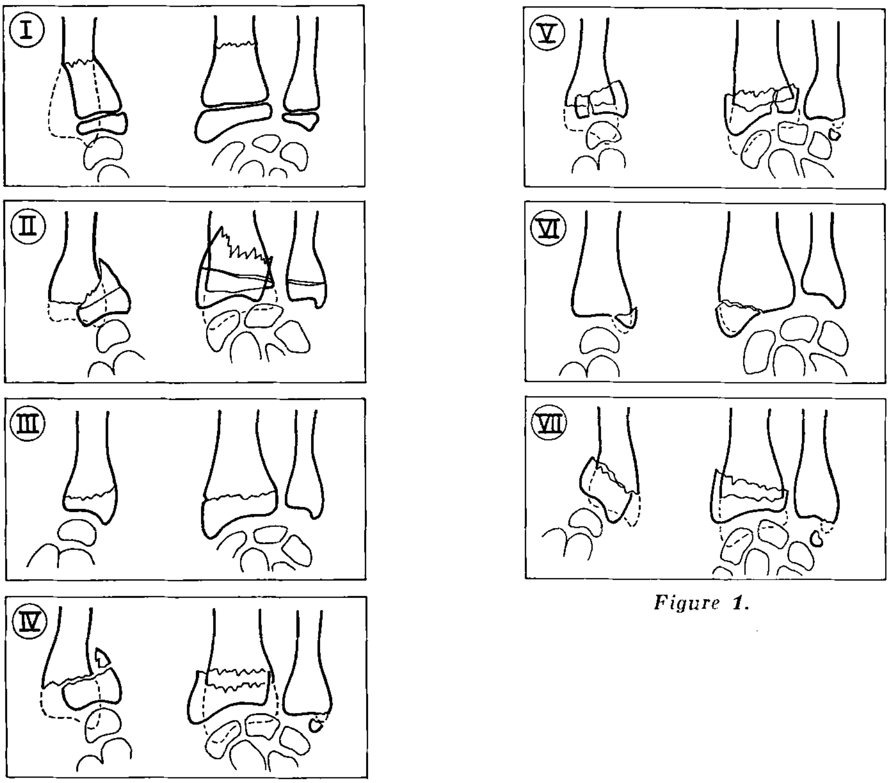

Figure 1.

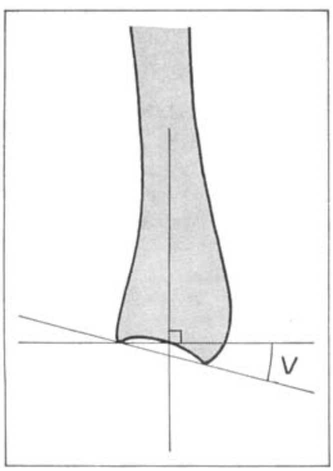

Figure 2.

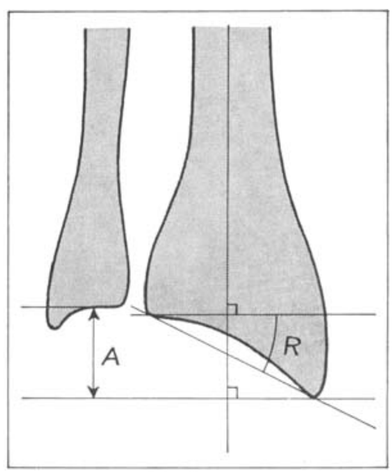

Figure 3.

The two most common fractures are types 4 and 5, i.e. greatly displace and/or intraarticular (Nissen-Lie 1939, Højensgård 1945, Ingebrigtsen 1946, Erin Madsen 1949, Lindström 1959). The displacement of the fractures was assessed by measuring the angle made by the distal articular surface of the radius in relation to the longitudinal axis, partly in the lateral view, the volar angle called V, and partly in the anteroposterior view, the radial angle called R (Figures 2 and 3), (Dowling & Sawyer 1961). The shortening, called A, was measured as is apparent from Figure 3.

The volar angle (V) is normally 12°, the radial angle (R) 23°, and the measure used for expressing the shortening (A) is normally 12 mm (Scheck 1962).

All patients were admitted for reduction which was performed under general anaesthesia and with fluoroscopic control.

The material comprises 100 patients treated by circular forearm plaster cast and 100 patients treated by circular high cast, i.e. a circular cast from the knuckles to past the middle of the upper arm. All the patients were admitted to the County and City Hospital, Kolding, during the period 1960 to 1964. The group treated by forearm cast was from the period 1960 to 1962 and the group treated by high cast from the period 1962 to 1964.

The sex ratio among all 200 patients was 73 per cent females and 27 per cent males, in accordance with previous authors' findings (Alffram & Bauer 1962).

RESULTS

Table 1 lists the average of the volar angle V during the treatment. The first 3 columns give the various types of fracture, the percentage distribution, and method of treatment, the next 2 show the mean of the volar angle before and after reduction, and the last 2 columns the

Table 1. The volar angle, V, during treatment.

Type	%	Cast	Before reduction	After reduction	1 week later	3 weeks later
I	6	low	16° dors.	6° vol.	4° vol.	6° vol.
	15	high	19° dors.	5° vol.	5° vol.	3° vol.
II	6		27° dors.	8° vol.	9° vol.	9° vol.
	7		29° dors.	6° vol.	2° vol.	2° vol.
III	5		8° dors.	5° vol.	6° dors.	6° dors.
IV	48		23° dors.	6° vol.	3° vol.	1° dors.
	44		25° dors.	4° vol.	2° dors.	2° dors.
V	33		25° dors.	7° vol.	1° vol.	1° dors.
	23		24° dors.	4° vol.	6° dors.	3° dors.
VII	7		19° vol.	12° vol.	15° vol.	10° vol.
	6		18° vol.	6° vol.	17° vol.	13° vol.

Table 2. The radial angle, R, during treatment.

Type	%	Cast	Before reduction	After reduction	1 week later	3 weeks later
I	6	low	20°	21°	22°	20°
	15	high	17°	20°	21°	20°
II	6		22°	23°	22°	25°
	7		19°	22°	22°	22°
III	5		20°	24°	20°	20°
IV	48		18°	23°	22°	20°
	44		18°	22°	21°	19°
V	33		16°	24°	23°	20°
	23		15°	23°	22°	21°
VII	7		19°	24°	25°	24°
	6		16°	20°	23°	20°

volar angle at the end of 1 week and at the end of 3 weeks after the reduction.

The most important types of fractures are IV and V, being the most common and also the most serious ones with respect to the severity of the injury, i.e. comminuted and/or intra-articular.

Table 2 presents the mean of the radial angle R during the treatment. Table 3 shows the distance A, i.e. the measure which expresses

Table 3. Distance, A, during treatment.

Type	%	Cast	Before reduction	After reduction	3rd week	Total shortening
I	6	low	11 mm	13 mm	9 mm	4 mm
	15	high	12 mm	14 mm	7 mm	7 mm
II	6		12 mm	14 mm	10 mm	4 mm
	7		11 mm	12 mm	8 mm	4 mm
III	5		11 mm	13 mm	7 mm	6 mm
IV	48		10 mm	14 mm	8 mm	6 mm
	44		11 mm	14 mm	8 mm	6 mm
V	33		9 mm	13 mm	8 mm	5 mm
	23		10 mm	14 mm	9 mm	5 mm
VII	7		12 mm	13 mm	9 mm	4 mm
	6		12 mm	13 mm	7 mm	6 mm

Table 4. Time of displacement for all fractures.

Type	%	Cast	Displacement 1st week	Displacement 3rd week	Total displacement	No. displacement
I	6	low	2	0	2	4
	15	high	2	3	5	10
II	6		2	1	3	3
	7		0	0	0	7
III	5		2	1	3	2
IV	48		11	10	21 (45 %)	19
	44		14	11	25 (58 %)	27
V	33		11	4	15 (40 %)	18
	23		10	1	11 (48 %)	12
VII	7		4	0	4	3
	6		0	0	0	6

the shortening of the radius during the treatment. Table 4 sets out the mean time of displacement of the various types of fracture.

The only complaint on account of the plaster cast was pressure traces in the cubital fossa which did not in any case interfere with training of the elbow. The three-week immobilization in plaster caused only little reduction in elbow mobility which returned to normal quickly, *viz.* in the course of a week or so.

DISCUSSION

The object of the treatment was to avoid primary formation of oedema, which makes the plaster cast too large in a few days. Therefore, local anaesthesia was not applied, but the reduction was performed under general anaesthesia. A circular plaster cast was applied and the patients were kept in hospital for at least 24 hours. The arm was elevated and active exercises were started.

X-ray follow-up was done 1 and 3 weeks after the reduction. In patients with a high cast the cast was shortened to below the elbow three weeks after the reduction. The cast was finally removed six weeks after the reduction, in a few cases somewhat earlier.

From Table 1 it may be seen for types 4 and 5 that although the V points nicely into the volar direction after the reduction, it ends negative, i.e. the articular surface facing dorsally. The difference is not many degrees, but nevertheless the articular surface had slid an average of about 10° dorsalward during the treatment. In the other types the position of the articular surface showed varying degrees of exacerbation. In type 7 no exacerbation had occurred, and indeed this would not be expected, as this type of fracture hardly ever gets dorsally displaced, displacement, if any, being into the volar direction. It is also apparent that the secondary displacements that occur take place to the same extent in the two groups of patients, i.e. both in the group treated by circular low cast and in the group treated by circular high cast.

As might be expected, most displacements had occurred among fractures of types 4 and 5, i.e. comminuted and/or intra-articular fractures. Table 4, column 6, giving total displacements, shows the percentage of displacements occurring in fractures of these types. It is apparent that almost one-half undergo secondary displacement, i.e. they become displaced by more than approx. 10° whether they are treated by low or high cast.

What was not measured in the present investigation was the displacement which may take place due to radial parallel displacement of the distal fragment in relation to the proximal part of the radius. This might be ascertained by measuring how far a line sagittally through the middle of the distal fragment had been shifted in relation to a similar line through the proximal portion of the radius. However, this was not measured, as in the author's opinion it is exceptional for a fracture distally in the forearm to get displaced by parallel displacement of the distal fragment without shortening or alteration of the position of the articular surface in at least one of the two views.

The purpose of the study was to gain an impression of the degree of the displacement of the distal fragment in fractures of the distal part of the forearm, expressed by the 3 above-mentioned parameters which afford an impression of this problem with the reserve which applies to the error in measuring angles on X-ray films. However, the difference is so great that it must represent the degree of exacerbation in the position of the fracture which has taken place. The degree of exacerbation for the individual types of fracture is evenly distributed in the material. None exceeds 14°, and only 5 of each therapeutic group exceed 10°, so that the result is not influenced by a few fractures with extreme values. It is apparent from the results that the distal fragment gets displaced to the same extent and with the same frequency whether the fracture is treated by circular high cast or by circular low cast. With respect to the shortening that occurs, there is also no major difference, neither between the two groups of patients nor between the various types of fracture, and thereby between the two methods of treatment.

There is also no essential difference in the time at which the displacement takes place. This time is largely unchanged despite immobilization of the elbow in one of the groups. It might be imagined that a better result would manifest itself in the displacement occurring at a later juncture in the group of patients treated by a high cast. This would not have been detected if only the end result were assessed.

CONCLUSION

The present study does not confirm the assumption that the results of treating fractures in the distal part of the forearm may be improved by including the elbow in the plaster cast.

SUMMARY

Out of 200 patients with fracture in the distal part of the forearm, 100 were treated by circular low plaster cast and 100 by circular high cast. Thereafter, the alteration in the articular surface of the distal end of the radius was studied radiologically in two projections.

The fractures were classified into 7 groups as suggested by Nissen-Lie (Figure 1). The measurements used are shown in Figures 2 and 3.

The position of the articular surfaces in the lateral view before and after reduction and dressing as well as the end results are given in Table 1 for high cast. The changes in the position of the articular surfaces in the anteroposterior view that had occurred during the treatment are given in degrees in Table 2. Table 3 presents the shortening that had taken place during the treatment period.

The time of the secondary displacement is shown in Table 4 for fractures treated with low and high cast respectively.

The investigations revealed that the therapeutic result, i.e. the incidence of secondary displacement is not improved by including the elbow in the plaster cast.

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