

## EVALUATION OF HEALED COLLES' FRACTURES

BY JOHN J. GARTLAND, JR., M.D., AND CHARLES W. WERLEY, M.D.,  
PHILADELPHIA, PENNSYLVANIA

*From the Departments of Orthopaedic Surgery and Radiology,  
Jefferson Medical College Hospital, Philadelphia*

An analysis of a series of healed Colles' fractures has been made for a twofold purpose: to determine, if possible, what factors are responsible for unsatisfactory end results, and to evaluate a method of treatment widely advocated and commonly used. The fractures in this series were treated at an active general hospital by general surgeons, orthopaedic surgeons, and resident surgeons. The follow-up results are believed to be representative of end results obtainable in any institution in which this fracture is similarly treated and studied.

### METHOD OF STUDY

At the time of the evaluation examination a complete fracture history was taken and a physical examination was made of both wrists, including accurate measurement of all wrist motions with a goniometer according to the method of Cave. A series of five roentgenograms was then made of both the normal and the injured wrist, from the following positions: (1) anteroposterior, (2) lateral, (3) oblique, (4) with the hand in complete radial deviation, and (5) with the hand in complete ulnar deviation. These roentgenograms, together with the prereduction, postreduction, and follow-up films, gave us complete roentgenographic coverage of all phases of the fracture. In addition an interval film, made at the time plaster fixation was discarded, was available for study in 50 per cent. of the cases.

The components of a Colles' fracture include dorsal tilt of the distal radial fragment and loss of the normal medial tilt of the distal end of the radius, both measured in degrees, and shortening of the radius, measured in millimeters. The value for each component was computed on each of the roentgenograms by direct measurement (Fig. 1). This method of measurement made it possible to observe the behavior of each fracture component as healing progressed (Figs. 2-A to 2-E).

### SELECTION OF CASES AND METHODS OF TREATMENT

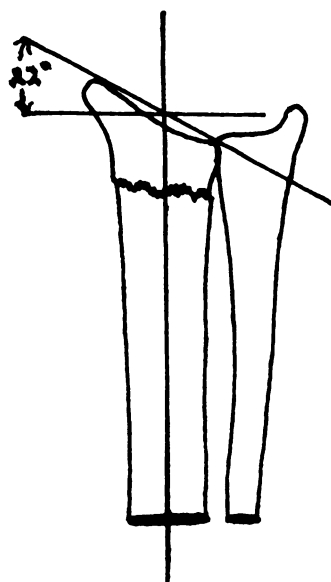
This method of study was applied to sixty cases. Three constants were maintained in selecting these cases:

1. Each had had a true Colles' fracture;
2. Each was re-examined one year after the fracture or later;
3. The method of reduction, type of immobilization, and follow-up care of the original injury had been the same in each case.

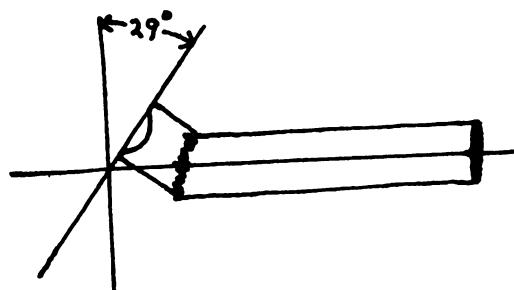
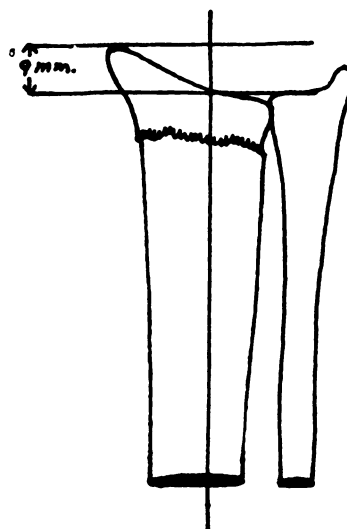
This was a series of fractures in adults averaging fifty-three years of age. The ratio of females to males was three to one. The follow-up period ranged from twelve to forty-six months, with an average of eighteen months.

Each of the fractures was first treated by the usual method of closed manipulation. Local anaesthesia was used in two thirds of the cases and a general anaesthetic in the others. Fluoroscopic control was used in one third. Immobilization was effected by means of lightly padded dorsal and volar plaster splints held in place by a circular gauze bandage. Splints extended from just proximal to the metacarpal heads to the upper portion of the forearm just below the elbow. The injured wrist was held in the position of palmar flexion and ulnar deviation for an average period of two weeks. The splints were then re-applied with the wrist in neutral position. The total period of immobilization averaged six weeks.

## Radial Deviation



## Shortening



## Dorsal Tilt

FIG. 1

Method used for measuring the value of each component. The appropriate angle or distance is read directly from the roentgenograms after these lines are drawn. The numbers indicated are measurements selected at random for illustrative purposes.

## FUNCTIONAL END RESULTS

Any method of fairly and accurately evaluating functional end results in fractures must include all aspects of the fracture and any sequelae. Therefore, it must take into account residual deformity, the subjective evaluation of the patient, the objective findings, and any complications arising directly from the fracture. For the purposes of this investigation a reasonably complete and exhaustive method of evaluating final functional end results was devised. This is a point system based on authoritative disability evaluation charts<sup>4</sup>, which takes into account all possible factors and gives each a point value relative to one another. Analysis of cases according to this point system has led to the formation of certain point ranges for each end-result group, and has thus provided a constant, rigid yardstick for evaluating each fracture (Table I). By applying this yardstick to the series of fractures it was possible to tabulate functional end results (Table II). At the end of the follow-up period, which averaged eighteen months, satisfactory results had been obtained in 68.3 per cent. of cases and unsatisfactory results in 31.7 per cent. The functional end results obtained in this common and often lightly regarded fracture were not felt to be very commendable and prompted an analysis of the following related factors.

The following roentgenograms represent the course of a typical fracture and indicate the method of measuring the fracture components at each stage.

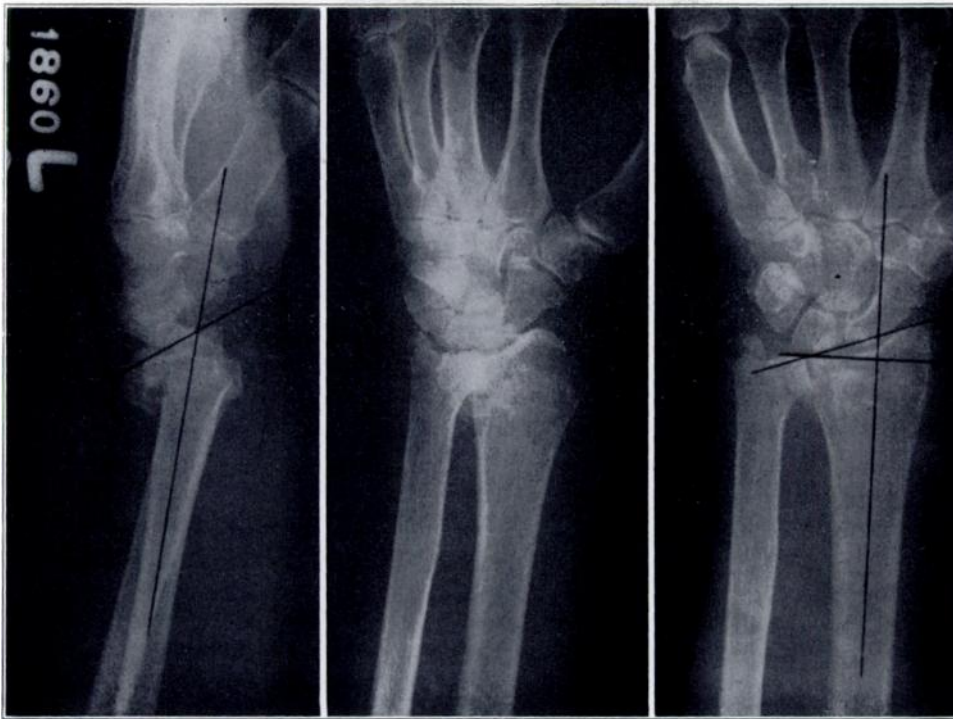


FIG. 2-A

Measurements made on pre-reduction film.

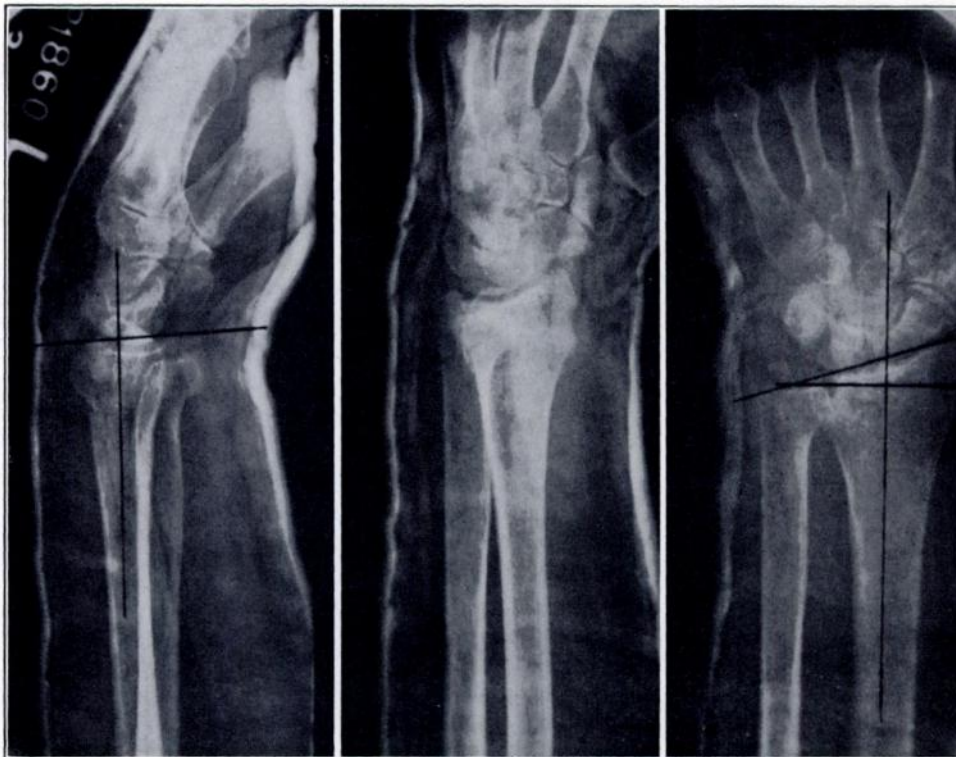


FIG. 2-B

Measurements on x-ray made immediately after reduction.

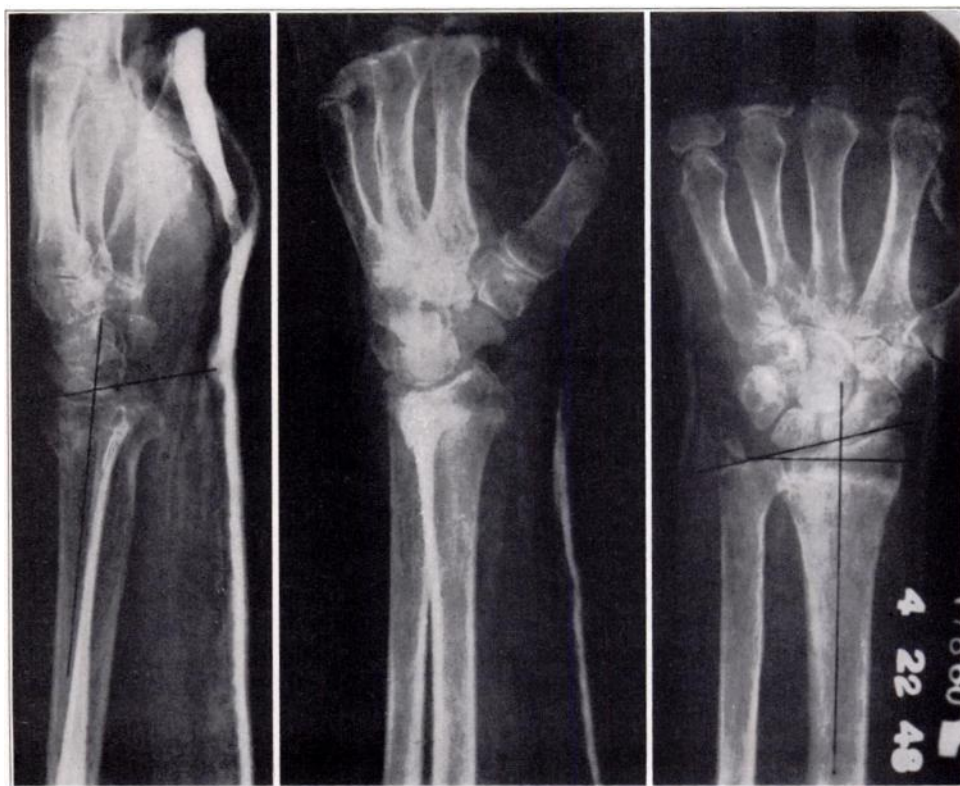


FIG. 2-C

Same patient. Measurements made on roentgenogram taken immediately after plaster was removed. (Average time of removal was six weeks after fracture.)

#### TYPES OF FRACTURE

It has been said that no two Colles' fractures are alike. Although this is not strictly true, the fractures may be grouped into several distinct types; a classification of these has been described<sup>5</sup>. For our purposes the fractures in this series were divided into three groups on the basis of the roentgenograms made before reduction:

Group I. Simple Colles' fracture with no involvement of the radial articular surface (seven cases, 12 per cent.).

Group II. Comminuted Colles' fracture with fractures of the radial articular surface in which the fragments were not displaced (twenty-seven cases, 45 per cent.).

Group III. Comminuted Colles' fracture with fractures of the radial articular surface in which the fragments were displaced (twenty-six cases, 43 per cent.).

This method of classification is important because the end result will depend to some extent upon the type of fracture sustained. Comminuted fractures are the most frequent, forming 88 per cent. of the cases in this series. When the type of fracture incurred is analyzed in relation to the ultimate end result, the bulk of unsatisfactory results will, of course, be found in the two groups with comminuted fractures (Table II). Unsatisfactory results were found in only 14 per cent. of the Group I fractures, while in Groups II and III the number rose to 27 per cent. and 42 per cent. respectively. It is evident that the type of fracture incurred is a factor in the prognosis.

#### COMPONENTS OF FRACTURE

##### A. *Dorsal Tilt*

The behavior of the actual fracture components themselves was next investigated. In the normal wrist the lower end of the radius has a distinct anterior concavity and the



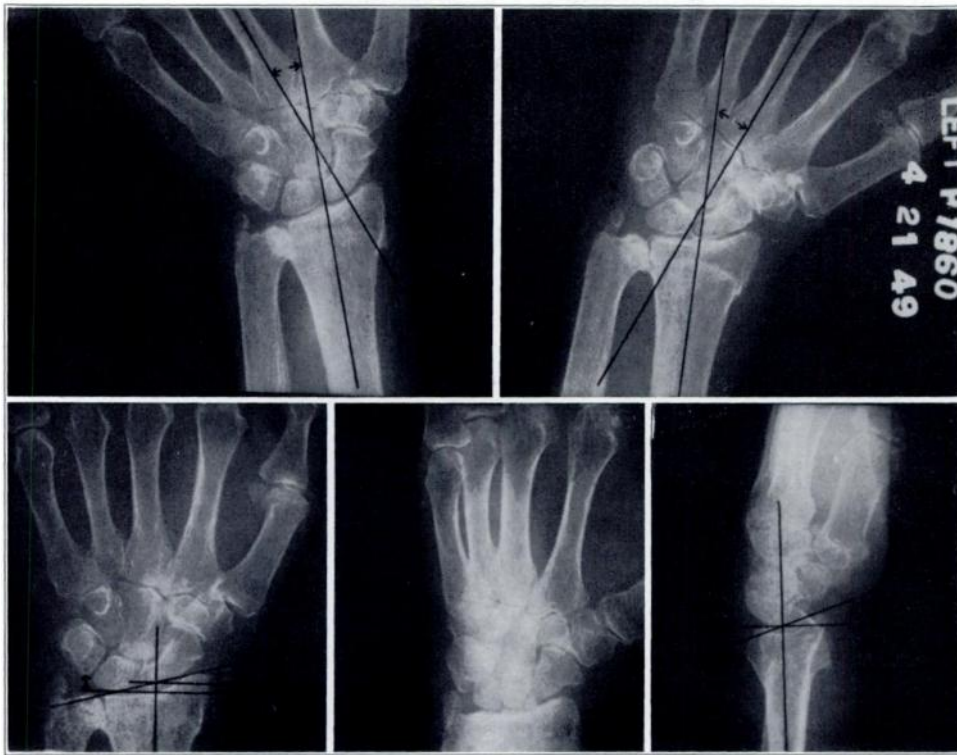


FIG. 2-D

Measurements made for evaluation of disability (average, 18 months after fracture).



FIG. 2-E

Measurements of normal right hand, made at same time as roentgenogram shown in Fig. 2-D.

TABLE I  
POINT SYSTEM USED TO EVALUATE END RESULTS OF HEALED COLLES' FRACTURES

Result	Points
Residual Deformity	
Prominent ulnar styloid	1
Residual dorsal tilt	2
Radial deviation of hand	2 to 3
Point range	0 to 3
Subjective Evaluation	
Excellent. No pain, disability, or limitation of motion	0
Good. Occasional pain, slight limitation of motion, no disability	2
Fair. Occasional pain, some limitation of motion, feeling of weakness in wrist, no particular disability if careful, activities slightly restricted	4
Poor. Pain, limitation of motion, disability, activities more or less markedly restricted	6
Point range	0 to 6
Objective Evaluation *	
Loss of dorsiflexion	5
Loss of ulnar deviation	3
Loss of supination	2
Loss of palmar flexion	1
Loss of radial deviation	1
Loss of circumduction	1
Pain in distal radio-ulnar joint	1
Point range	0 to 5
Complications	
Arthritic change	
Minimal	1
Minimal with pain	3
Moderate	2
Moderate with pain	4
Severe	3
Severe with pain	5
Nerve complications (median)	1 to 3
Poor finger function due to cast	1 to 2
Point range	0 to 5
End-result point ranges	
Excellent	0 to 2
Good	3 to 8
Fair	9 to 20
Poor	21 and above

\* The objective evaluation is based upon the following ranges of motion as being the minimum for normal function: dorsiflexion, 45 degrees; palmar flexion, 30 degrees; radial deviation, 15 degrees; ulnar deviation, 15 degrees; pronation, 50 degrees; and supination, 50 degrees.

articular surface is directed slightly forward as well as downward. This so-called volar tilt of the distal radial articular surface can be measured in degrees.

The normal range in our series was +1 degree to +21 degrees, with an average volar

TABLE II  
END RESULTS AT TIME OF FOLLOW-UP EXAMINATION  
(Results for total number of cases and for each of the three groups)

End Results	Total Cases		Group I (7 Cases)		Group II (27 Cases)		Group III (26 Cases)	
	No.	Per cent.	No. of Cases	Per cent.	No. of Cases	Per cent.	No. of Cases	Per cent.
Excellent	13	22	3	43	9	33	1	4
Good	28	47	3	43	11	40	14	54
Fair	17	28	1	14	6	22	10	38
Poor	2	3	0	0	1	5	1	4

tilt of +11 degrees. After a Colles' fracture the distal radial fragment is displaced and tilted backward. This dorsal tilt was measured in minus degrees.

Study of the position of the distal radial fragment in this plane during the several phases of the fracture treatment showed, first of all, that the original amount of dorsal tilt has no appreciable effect on the ultimate end result. A comparable and apparently satisfactory reduction was carried out in all groups as far as this component was concerned (Table III). It will be noted, however, that this component does not stay reduced. As healing progresses, this factor in the reduction is lost, and residual dorsal tilt is found in

TABLE III  
DORSAL TILT AS SHOWN IN ROENTGENOGRAMS

End Result	X-ray Before Reduction (Degrees)	X-ray After Reduction (Degrees)	Interval X-ray (In 50 percent. of all cases) (Degrees)	Follow-up X-ray (Degrees)
Excellent	-15	+6	+3	0
Good	-21	+2	+3	-2
Fair	-20	+4	-2	-5

the end results of all cases except those in the excellent group. It is evident, then, that this component of the fracture is not being adequately reduced. In no group has the dorsal tilt been corrected sufficiently to compensate for the loss which will occur as healing progresses. Since the functional end result becomes worse as the amount of residual dorsal tilt increases, the minimum standard for this component of the reduction should be an average volar tilt of at least +11 degrees in order to compensate adequately for the loss of correction which will occur.

The fact that some loss of this part of the reduction occurs between the postreduction

TABLE IV  
RADIAL DEVIATION AS SHOWN IN ROENTGENOGRAMS  
(Normal deviation: 23 degrees)

End Result	X-ray Before Reduction (Degrees)	X-ray After Reduction (Degrees)	Interval X-ray (In 50 per cent. of all cases) (Degrees)	Follow-up X-ray (Degrees)
Excellent	20	22	20	20
Good	16	18	16	16
Fair	19	21	19	19

period and the time of the interval film—that is, during the period of immobilization—throws some doubt on the adequacy of immobilization. The fact that even greater loss of this component occurs between the time of the interval film and the follow-up film has also led us to question whether the period of immobilization—an average of six weeks in this series—has been sufficient.

### B. Radial Deviation

The second characteristic pathological finding in a Colles' fracture is some loss of the normal inward tilt of the distal end of the radius, due to impaction and radial deviation of the distal fragment. Normally in our series this inward tilt ranged from 13 to 30 degrees, with an average of 23 degrees. After a Colles' fracture, this angle is decreased and in our series has been found to be as low as 4 degrees.

From a review of the several phases of the fracture treatment it is evident that the behavior of this component follows a pattern identical to that of residual dorsal tilt (Table IV). A certain amount of correction is obtained at the time of reduction, but, like dorsal tilt, this component of the fracture does not stay reduced. In fact, this part of the reduction is lost completely in all groups between the postreduction and interval films, that is, while the wrist is in the cast. On the interval film the fractures in all groups show an amount of residual radial deviation equal to that of the original injury. Again this is evi-

TABLE V  
EXTENT OF SHORTENING AS SHOWN IN ROENTGENOGRAMS

End Result	X-ray Before Reduction ( <i>Millimeters</i> )	X-ray After Reduction ( <i>Millimeters</i> )	Interval X-ray (In 50 per cent. of all cases) ( <i>Millimeters</i> )	Follow-up X-ray ( <i>Millimeters</i> )
Excellent	2.0	1.3	2.3	2.2
Good	3.7	1.3	3.4	3.3
Fair	2.8	1.4	3.5	3.9

dence that the method of immobilization used is unsatisfactory. In the light of these facts, we cannot say that the original reduction of this component of the fracture was adequate. It has been said that the normal inward tilt of the distal end of the radius averages 23 degrees. In no group has radial deviation been corrected sufficiently at the time of the original reduction to compensate for the loss which will occur with the type of immobilization used. The minimum standard for this component of the reduction should be the average value of at least 23 degrees. The amount of residual radial deviation, however, unlike dorsal tilt, does not appear to have any appreciable relationship to the end result, as was seen on the follow-up films of cases in our series.

In a high percentage of cases radial deviation is associated with a rotation of the distal radial fragment on its long axis in a direction of supination. As the fracturing force strikes the pronated hand, the distal radial fragment is displaced backward. This backward displacement produces tension on the fibrocartilage, with the result that the lower fragment is pivoted around the head of the ulna in a direction of supination. This supination twist of the distal radial fragment can be seen roentgenographically if both bones are shown on the anteroposterior roentgenogram. Such a picture would show a normal anteroposterior view of the upper end of the radius with a normal lateral view of the lower end of the radius<sup>3</sup>. Detection of this twist in the usual roentgenogram of the lower end of the radius is not easy. In the usual lateral view the distal fragment will appear to be displaced backward. The anteroposterior view will show apparent radial deviation of the distal fragment, which seems to overlap the proximal fragment on its outer side, and to be



slightly broadened in comparison with it. However, Mayer's experiments demonstrated that "no such backward or radial displacement was in fact present and these appearances are typical of a severe supination-twist".

In our series 52 per cent. showed it and 48 per cent. did not. Displacement was equally distributed among the end-result groups. The number of cases losing the radial deviation component of the reduction during immobilization was the same (65 per cent.) in the group with supination twist as in the group without this complication. It has been found, however, that those patients with supination twist show a greater loss of the inward tilt of the distal end of the radius at the time of fracture. The effect of supination twist is apparently counteracted by immobilization during the healing period. This evidence would lead to the conclusion that supination twist of the distal radial fragment at the time of fracture does not influence the functional end result as long as reduction of this component of the fracture can be adequately maintained. Its only effect would seem to be that it increases the difficulty of adequately maintaining the normal inward tilt of the distal radial fragment. It forms the logical basis for immobilizing these fractured wrists in pronation.

### *C. Shortening*

The third component of a Colles' fracture to be examined is shortening of the radius. Shortening results from a combination of impaction, loss of the normal inward radial tilt, and absorption of bone at the fracture site. From a study of Table V it can be seen that, regardless of the extent of original shortening, a comparable reduction has been achieved in all groups. However, this component of the fracture, like the other two already discussed, does not stay reduced. In all groups this part of the reduction is completely lost between the time of the postreduction film and the interval film,—that is, while the wrist is in the cast. In all groups the amount of shortening shown on the interval film was equal to that present immediately after the original injury. Again this is evidence that the method of immobilization is inefficient.

It is difficult to determine whether or not this component of the fracture has been adequately reduced. Certainly reduction has not been complete, for all groups show a residual shortening, and although this is inconsiderable, it increases during the healing period. As much shortening as possible, then, must be corrected at the time of reduction, since, with the type of immobilization used in this series, this length will not be completely maintained during the healing period.

### *D. Distal Radio-Ulnar Joint*

Loss of integrity of the distal radio-ulnar joint has been indicted as the cause for most of the poor results after this fracture<sup>2, 7</sup>. In the normal wrist, the integrity of the distal radio-ulnar joint is maintained by a triangular fibrocartilage. This fibrocartilage runs from the distal margin of the ulnar notch of the radius to the base of the ulnar styloid. In a Colles' fracture the breaking of the distal end of the radius, with its impaction and dorsal displacement, attenuates this fibrocartilage to a maximum degree and beyond, because of the volar displacement of the ulnar head. Two factors aid in preventing rupture of this ligament in a Colles' fracture. The first is avulsion of the medial posterior portion of the distal end of the radius, which contains the ulnar notch, and hence the insertion of the base of the triangular fibrocartilage; in our series this element of the fracture was present in 86 per cent. of the cases. The second factor is avulsion of the base of the ulnar styloid, and hence of the other insertion of the triangular fibrocartilage; this component of the fracture was present in 47 per cent. of our cases. The anatomical arrangement of this fibrocartilage explains the frequent occurrence of these fractures. Both of these types of fracture lead to subluxation of the distal radio-ulnar joint. Rupture of this fibrocartilage can be diagnosed when the integrity of the distal radio-ulnar joint is lost and neither of

these types of fracture has occurred. This complication did not arise in any of our cases.

In our series, the follow-up films of eighteen cases showed residual disruption of the distal radio-ulnar joint. Only six of these patients complained of any pain on supination or on compression of the distal radio-ulnar joint. The average loss of supination for the cases showing loss of integrity of the distal radio-ulnar joint was 20 degrees. In our analysis, 61 per cent. of these cases were listed among the satisfactory end results and 39 per cent. among the unsatisfactory results. This ratio is about the same as for the series as a whole. If this were the major cause for poor results, a much higher percentage of unsatisfactory results might be expected. Although loss of integrity of the distal radio-ulnar joint may be one cause of an occasional poor result, it is certainly not often a cause in the average case.

#### EFFICIENCY OF IMMOBILIZATION

Thus far, the evidence from a study of the components of Colles' fractures indicates that these fractures are being incompletely reduced. How efficient was the method of immobilization used in this series? Analysis of dorsal tilt, radial deviation, and shortening has shown that these components of the reduction are lost completely during the healing period. The cause must be inadequate immobilization. Further evidence that this method of immobilization is insufficient is furnished by the fact that a total of 33 per cent. of the cases showed a loss of volar tilt of 10 degrees or more during the healing period. A loss of

TABLE VI  
EFFECTS OF RESIDUAL DORSAL TILT ON DORSIFLEXION AND PALMAR FLEXION

Volar-Dorsal Tilt (Normal: +11 degrees) (Degrees)	Dorsiflexion (Normal: 61 degrees) (Degrees)	Palmar Flexion (Normal: 54 degrees) (Degrees)
+11 to 0 (26 cases)	52	50
0 to -10 (21 cases)	56	44
-11 and above (13 cases)	52	33

more than 3 degrees of radial deviation was seen in 31 per cent. of all cases, and shortening of three millimeters or more occurred during the healing period in 30 per cent. of the cases. From these figures it would seem that the method of immobilization used in this series was an inefficient method of external fixation for the average Colles' fracture. Thus faulty immobilization is one of the chief factors in this series operating against the achievement of satisfactory end results. This is borne out by the fact that 62 per cent. of the excellent end results showed no loss of reduction during the healing period. In the good group the total dropped to 40 per cent., and in the fair group to only 23 per cent. of cases.

#### FUNCTION STUDY

It has been stated that residual dorsal tilt is detrimental to function because of its deleterious effect upon dorsal and palmar flexion of the wrist joint. Likewise residual

TABLE VII  
MEASUREMENT OF EFFECTS OF RESIDUAL RADIAL TILT ON RADIAL AND ULNAR DEVIATION

Radial Tilt (Normal: 23 degrees) (Degrees)	No. of Cases	Radial Deviation (Normal: 20 degrees) (Degrees)	Ulnar Deviation (Normal: 33 degrees) (Degrees)
23 to 18	32	20	31
17 to 13	22	20	28
12 and below	6	24	24

TABLE VIII  
RADIAL AND ULNAR DEVIATION

Shortening ( <i>Millimeters</i> )	No. of Cases	Radial Deviation (Normal: 20 degrees) ( <i>Degrees</i> )	Ulnar Deviation (Normal: 33 degrees) ( <i>Degrees</i> )
0 to 3	36	19	31
4 or more	24	21	26

radial tilt and shortening have been condemned because of their effect upon lateral motions of the hand and wrist<sup>4,7</sup>. These effects have been seen often enough to validate what originated as a clinical impression. However, no effort has been made to evaluate these effects in a quantitative way. The authors felt, therefore, that this study afforded an excellent opportunity of measuring the effect of each residual component on function. The normal averages for dorsiflexion and palmar flexion were obtained from the uninjured wrist. The normal averages for radial and ulnar deviation of the wrist were obtained from the follow-up control films of the uninjured wrist.

The effects of residual dorsal tilt on dorsiflexion are summarized in Table VI. The normal average dorsiflexion of the uninjured wrist in this series was 61 degrees. In those cases in which the position of the distal part of the radius ranged from normal volar tilt to 0 degrees on the follow-up films, dorsiflexion averaged 52 degrees. This slight decrease below normal is attributable, we believe, to the stiffening effect of trauma and immobilization on the soft parts. A slight increase in dorsiflexion—to 56 degrees—was seen in those cases in which dorsal tilt ranged from 0 degrees to -10 degrees. This increase is due to the fact that residual dorsal tilt shifts the arc of this motion backward so that in full extension the normal limit theoretically will be exceeded. Dorsiflexion also averaged 52 degrees in those cases which had a residual dorsal tilt of -11 degrees or more. In these cases it seems reasonable to suppose that the backward shift of the motion arc was offset by the effect of more severe trauma. In general, residual dorsal tilt had no appreciable effect on dorsiflexion in our cases.

The normal average palmar flexion of the uninjured wrist in this series was 54 degrees. In those cases in which position of the distal end of the radius ranged from normal volar tilt to 0 degrees on the follow-up films, palmar flexion averaged 50 degrees. A drop to 44 degrees was seen in those cases ranging from 0 degrees to a residual dorsal tilt of -10 degrees. Palmar flexion further decreased to 33 degrees in those cases showing residual dorsal tilt of -11 degrees or more. In general, residual dorsal tilt has a decreasing effect on palmar flexion, and in cases with a residual dorsal tilt of -11 degrees or more the decrease is significant.

The effects of residual radial tilt on radial and ulnar deviation of the hand are summarized in Table VII. Normal radial deviation in our series averaged 20 degrees and ulnar deviation 33 degrees. Residual radial tilt was not found to have any appreciably significant effect on lateral motions at the wrist in our cases. Residual shortening appears to have little more effect on lateral motions at the wrist than does radial tilt (Table VIII). In general, however, it is evident that extreme degrees of both residual radial tilt and shortening will tend to increase the amount of radial deviation and decrease ulnar deviation at the wrist joint.

#### COMPLICATIONS

Among the unwelcome complications of Colles' fractures are stiff fingers and arthritis of the wrist joint. The wrist joint suffers injury when the distal radial articular surface is fractured. This occurred in 88 per cent. of our cases (Groups II and III). The functional hazard of this injury lies in the development of traumatic arthritis if the articular damage

is not accurately reduced. Roentgenographic evidence of arthritis in the follow-up films was present in a total of 22 per cent. of the cases. Arthritis did not develop in any of seven cases of simple Colles' fracture with no involvement of the radial articular surface (Group I). Of twenty-seven cases of comminuted Colles' fracture in which the fragments of the radial articular surface were not displaced (Group II), arthritis developed in three, or 11 per cent. Of twenty-six cases of comminuted Colles' fracture in which the fragments of the radial articular surface were displaced (Group III), arthritis developed in ten cases, or 40 per cent. At the end of the follow-up period none of the patients with excellent end results showed any arthritis, whereas in 14 per cent. of the cases with good, and in 41 per cent. of those with fair results, traumatic arthritis of the wrist joint developed in consequence of the Colles' fracture.

The ultimate development of traumatic arthritis is largely determined by the amount of bone damage incurred at the time of injury. In a great many cases, however, this complication can be avoided by accurate reduction and efficient immobilization. Thus, if traumatic arthritis does develop, it can result only from one of the following causes, or a combination of them: severe trauma to the distal radial articular surface, inadequate reduction, or inefficient immobilization.

Residual finger stiffness in varying degree was present in 18 per cent. of our cases at the follow-up examination and was due in every instance to faulty application of the cast. This stiffness, it will be remembered, was found on the follow-up examination, made on the average eighteen months after fracture. This is an extremely high toll to pay for a careless error, and emphasizes again the fundamental rule that the cast must stop proximal to the metacarpal heads on the dorsal surface and at the distal flexion crease on the volar surface.

#### CONCLUSIONS

It has been shown that the type of Colles' fracture incurred bears a definite relationship to the end result obtained. A fairly high percentage of unsatisfactory end results was found in the two groups with comminuted fractures. In addition, in a comminuted Colles' fracture the threat of traumatic arthritis is always present. The basic nature of the fracture must therefore be considered a factor in the prognosis.

The study of the fracture components themselves has demonstrated that the original reduction in all cases has been inadequate. The importance of this factor in influencing end results is illustrated by the fact that those cases showing the most complete reductions have been listed among the excellent end results. Among the fracture components, residual dorsal tilt has a more direct influence on an unfavorable end result than either residual radial deviation, residual shortening, or loss of integrity of the distal radio-ulnar joint.

The method of immobilization used in this series was inefficient and inadequate. Sixty per cent. of our cases, when re-examined eighteen months after injury, showed a fracture healed in a position typical of a fresh unreduced Colles' fracture.

In spite of incomplete reduction and inadequate immobilization the functional results at the time of the follow-up examination were found to be surprisingly good. Satisfactory functional end results were obtained in 68.3 per cent. of cases in this series. The chief credit for this percentage must be given to the innate ability of the wrist joint to overcome and compensate for residual bony deformity, rather than to the original treatment. Studies of function have shown that a great deal of bony deformity must be present before any of the motions at the wrist are compromised. A total of 31.7 per cent. of unsatisfactory results, however, is much too high for a fracture which continues to be lightly regarded and for which treatment tends to follow a routine pattern. The fruits of this attitude are apparent when the entire course of the fracture is reviewed.

We believe that, aside from the specific type of fracture incurred, insufficient reduc-

tion and present inadequate methods of immobilization are the factors responsible for unsatisfactory functional end results in the healed Colles' fractures in this series.

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## AN ANOMALOUS TARSAL BONE

BY ALLAN B. HIRSCHTICK, M.D., CHICAGO, ILLINOIS

*From the Department of Orthopaedic Surgery, Chicago Medical School, Chicago*

The accessory tarsal bones were so well described by Pfitzner in 1896 and by Dwight in 1907 that few variations have been recorded. In more recent years, Milliken described

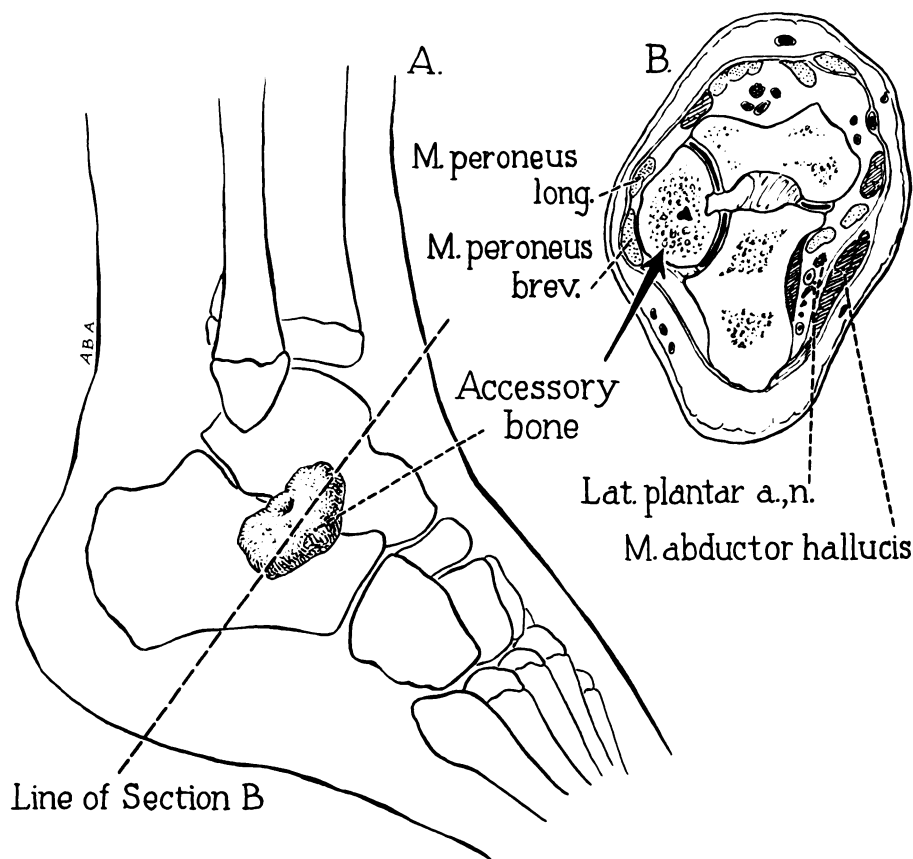


FIG. 1

Drawing showing the location and size of the anomalous tarsal bone.