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# COLLES' FRACTURE
## OPERATIVE TREATMENT, INDICATIONS AND RESULTS

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Colles' fracture, in Scandinavia generally termed fractura radii typica, belongs to the most frequent type of fracture. During the last five years, 1961–1965, the Emergency Service registered 57426 fractures, a total of which 10729, or about 18.7 per cent were fractura radii typica. A number of reports have been made on the results of conventional treatment of this type of fracture, among others the works of the Scandinavians *Nissen-Lie* (1939), *Rosen* (1947), *Madsen* (1949), *Wicklund & Müllern-Aspegren* (1956), and *Lidstrøm* (1959).

*Nissen-Lie's* grouping of fractures of the lower end of the radius has been generally accepted as a classification basis in the Scandinavian reports:

I. Fractures on the passage between the scapus and the lower end of the radius, most frequent in children one to fifteen years of age.
II. Epiphysiolysis in children and youths ten to twenty years of age.
III. Fractures through the lower end of the radius without dislocation.
IV. Fractura radii typica (Colles') with dorsal and volar dislocation.
V. Comminute fractures with one or more communications to the joint.
VI. Isolated fractures of the styloid process of the radius.
VII. Fractures with volar dislocation (Smith's).

The following are the results of Nissen-Lie's report, which covers 282 re-examined cases, classified as above:

I. 45 cases: All healed without lasting injury.
II. 32 cases: All healed without lasting injury.
III. 57 cases: 52 healed without lasting injury and 5 healed with a slight radial deviation.
IV-V. 143 cases of dislocated and partly comminute fractures of which 133 were controlled about one year after the time of injury:
103 (73 per cent) were free of symptoms and had full mobility.
16 (12 per cent) had slight radial deviation.
12 (9 per cent) expressed pain (only by use).
9 (7 per cent) had reduced mobility.
8 (6 per cent) showed marked radial dislocation.
VI. 10 cases: All free of symptoms.
VII. 5 cases: All healed with a slight radial deviation, otherwise free of symptoms.

In his report, *Nissen-Lie* classifies 26 cases, healed with slight radial deviation, as satisfactorily healed, thus giving an extremely low number of unsatisfactorily healed cases, representing only about 5 per cent of the total, and referring mainly to the displaced and comminute fractures in the groups IV and V.

*Madsen* reports a redisplacement of 39 per cent of the cases in group IV and 75 per cent in group V.

In addition *Lidstrøm* stresses the evident connection between the intra-articular fractures and the unsatisfactory results in his report, representing 8 per cent of the total number of cases.

On the other hand, *Bacon & Kurtzke* state that the average disability was 24 per cent in a study made of 2132 cases of Colles' fracture from the New York State Workmen's Compensation Board, while only 2.9 per cent of the cases were judged to have no permanent disability. However, X-ray examination of the anatomical results usually reveals a somewhat different picture:

In Nissen-Lie's groups IV and V, 70 per cent of the cases showed ideal initial reduction, in which a total of 60 per cent had a 4 mm or more shortened radius as a final result. Furthermore, 80 per cent of the cases in Nissen-Lie's groups IV and V showed varying degrees of clinical deformity of the hand, in eight cases characterized as severe, and in twenty-six cases as light. In comparison: Lidstrøm's total material shows redisplacement in 28 per cent of the cases.

These facts indicate, as commonly accepted, that poor anatomical or

cosmetic results are not necessarily connected with unsatisfactory functional results.

Lidstrøm draws the following conclusions in his report:

1. The prognosis was less favourable for intra-articular fractures than for other types of fractures.
2. Final deformity increased the risk of impaired function.
3. Posttraumatic causalgia was to a certain degree permanent with consequent loss of function.
4. Residual laxity in the distal radio-ulnar joint increased the risk of reduced function.

In connection with the second paragraph of the conclusions, it seems natural to consider alternative precautions to prevent deformity during or after reunion, for example through operative corrections.

Surgical interventions have been performed on this basis, partly as osteotomies to correct deviations, partly by bone grafting to correct disproportions between the radius and the ulnae in cases of shortened radius. These procedures, where grafts from the distal end of the ulnae or from the distal end of the upper radial fragment are wedged into the osteotomy of the lower end of the radius, have been described respectively by *Campbell* (1937) and *Durman* (1937). Ulnar pinning, to prevent displacement, was described by *De Palma* (1950), and closed medullary pinning by *Rush* (1954). Other operations have also been performed in order to improve mobility, for instance through resection of the lower end of the ulnae according to the original Darrach method.

In his report, *Lidström* recommends the following directions for operative correction:

1. The deformity should be severe.
2. Sufficient time must have elapsed after time of injury.
3. There should be no symptoms of posttraumatic disturbances or nerve injuries.
4. There should be no comminution of the articular surface or arthritis of the radio-carpal joint.
5. Operative correction of radio-ulnar instability is only indicated in cases where the capitulum ulnae is displaced out of the ulnar notch.

After thorough investigation, A. Kristiansen has worked out a method to prevent or correct final deformity of the radius. The method is based

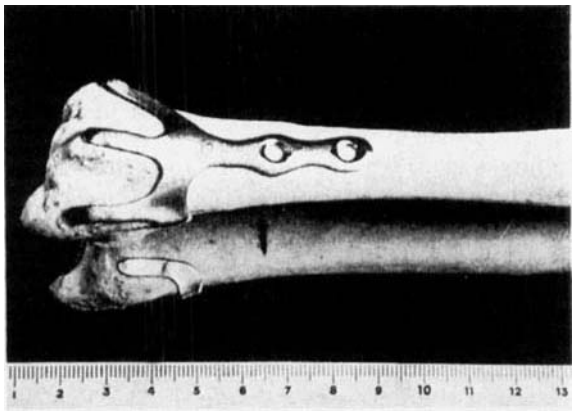

*Figure 1. Photo of the K-splint in situ on a radial bone, pictured with a mirror as background, thus showing both the dorsal and ventral side.*

on the principle of restoring the anatomical conditions by bone grafting, combined with an internal fixation of the fragments by means of a specially constructed surgical appliance.

In our opinion, the method will ensure better results for operations in the region of the radio-carpal joint, although the close anatomical relations in this area make surgical intervention rather complicated compared to operations on fractures adjacent to other joints of the extremities.

Close anatomical studies indicated the construction of an appliance, later called the K-splint, which is hand-shaped, with three fingers on the dorsal side and one finger on the radial side (Figure 1). The finger on the radial side, like a thumb, bends around the styloid process, keeps this in position, and continues on the other side to support the volar aspect of the radius.

The original intention was to locate the three fingers between the tendon channels.

Due to deformity and loss of structure and bone substance, the exact indicated positions of the fingers are often difficult to obtain. Practice proves however, that this does not influence the final result.

The K-splint is produced in three sizes from an alloy which, like the original Vitallium, consists of cobolt, chromium and molybdenum. In addition there is a T-shaped appliance, specially constructed to support the volar face of the radius in cases of Smith's fracture.

A retractor has also been constructed, one for each hand. This re-

tractor allows a steel wire, inserted between the radius and the surrounding soft tissues, to be stretched without interfering with X-ray examinations during operation.

Furthermore, a pair of modified Lambotte's forceps, adjusted to the broad volar aspect of the radius on one side and to the splint on the other side, is recommended to lock the splint to the radius. A pair of standard forceps for final adjustments of the K-splint's fingers is also required.

## THE OPERATION

The skin incision starts at the base of the thenar and continues with a slight dorsal curve along the tendon of the long abductor and short extensor muscles of the thumb. Then, on reaching the dorsal side of the radius, the incision is slightly curved in a volar direction up to a handsbreadth above the radio-carpal joint. The fascia is divided along the superficial radial nerve, which, together with its branches to the thumb, is exposed up to the crossing with the brachio-radial muscle. Here the nerve leaves the fascial layer, and is to be exposed by a pair of scissors with edge turned dorsally to divide the connective tissue between the brachio-radial and extensor carpi-radial muscles. The nerve is retracted dorsally. The brachio-radial muscle is loosened by subperiostal dissection from its insertion at the styloid process of the radius and retracted in volar direction. The periosteum is divided corresponding to the edge of the radius, and the fragments exposed by careful dissection in the subperiostal space.

Having obtained a good general view of the fracture and the crossed zone of bone, a suitable block of cancellous bone (without the cortical layer) is chiselled out of the iliac crest and trimmed to replace the crossed part of the bone. The K-splint is fixed to the proximal fragment by two screws. The fingers of the splint will then keep the distal fragments and the bone in position. If necessary, adjustments are made by the insertion of small cancellous bone grafts.

During the first ten days of aftertreatment, a simple volar splint is recommended. After the sutures are removed, a plaster cast is applied for 8–12 weeks.

X-ray examinations, with a carefully standardized technique, are carried out during the operation, two to seven days after the operation, and repeated every two or four weeks until the fracture is consolidated.

## THE CASES

This report covers a total of twenty-six patients, operated and followed up by Amund Kristiansen, reexamined and evaluated by Einar Gjersöe. Data are insufficient in three cases, all referring to older patients that died of other reasons during the follow-up period.

The remaining twenty-three cases consist of: Twenty-two patients with Colles' fracture, and one Smith's fracture.

The age of the three male and twenty female patients varied from thirty to seventy-two years, giving an average age of fifty-five years.

### *Indications*

I. Six patients had impaired function and/or pains as result of malunited fractures. Operations were performed between 41 and 189 days after injury.
II. Seventeen patients had redislocated fractures which were operated before the end of the reunion period. These patients were operated upon between 3 and 29 days after injury.

### *Complications*

I. Three cases of lesion of the dorsal skin innervation of the thumb, immediately treated with nerve sutures.
II. Two cases of superficial infection.
III. In four cases the K-splint was removed, in one case because it loosened after reunion, and in one case because it broke. In two cases the splint became too long after a second reduction of the length of the radius, thus interfering with the free movements of the hand.

### *Reexamination*

The average observation time in this report is four years and five months, varying from two years and ten months to nine years and six months.

At reexamination the following results were evaluated:

1. Anatomical results
2. Mobility
3. Pains

The patient's uninjured hand has been used as an evaluation basis for the anatomical results. In cases of previous fractures of the other

hand, the average values of this report's uninjured hands have been used for comparison:

Articulation surface in frontal projection: 116°.

Articulation surface in lateral projection: 81°.

Level difference between the point of the styloid process of the radius and the capitulum ulnae (called "d"): 12 mm.

These values correspond with the normal values indicated by de Palma, who states 120°/105° in frontal projection and 89°/67° in lateral projection, with an average of respectively 113° and 79°.

Like Nissen-Lie and others, we have used the difference in distance (distance = "d") between the top of the styloid process of the radius and the plane through the distal articular surface of ulnae as one method to measure shortening and redisplacement.

Usually, the shortening is located on the radial side, and in these cases the difference in "d" gives the actual shortening.

As this method of measuring the reduced length does not cover a possible shortening on the ulnar side of the radius, we have consequently measured the ulnar shortening, or the distance between the distal ulnar corner of the radius and the plane through the distal articular surface of the ulnae, and for practical reasons graded the distance as follows:

\+ 1– 5 mm
\+ + 6–10 mm
\+ + + more than 10 mm

The same system has been used in order to grade the volar displacement by measuring the distance between the most prominant part of the volar displaced fragment and the volar aspect of the radius, and the dorsal displacement by measuring the distance from the most prominent part of the dorsal-dislocated fragment to the dorsal aspect of the radius.

Final anatomical results.

The results of the operations performed and covered in this report have been divided into the following groups:

I. Excellent anatomical results. This group consists of seven patients, all with joint surfaces differing less than 10° in one or both projections from the uninjured hand. In four cases the divergence is less than 5°, and in all cases there is none or only minor reduction of "d" (less than 5 mm), and no ulnar shortening.

II. Good anatomical results. Six patients belong to this group. In these cases the articulation surface has a divergence of maximum 20° in one or both projections, and the reduction of "d" is less than 10 mm. The ulnar shortening does not exceed 5 mm (called +), and the angle of the articulation surface is less than 90° in the lateral view.

III. Fair anatomical results. This group includes four patients, all with an ulnar shortening of the radius not exceeding 10 mm (called + +). In one case the articulation surface has a divergence of 24° in the lateral projection. In the other cases the divergence is less than 20° in one or both projections. In two cases, the angle of the articulation surface is more than 90° in the lateral view.

IV. Poor anatomical results. In this group, which consists of six patients, the result may be characterized as less favorable than in group III. All patients have some dislocation ad axim. In five cases the angle of the articulation surface is not satisfactory.

*Function*

In cases that permit such a comparison, the evaluation of the mobility has been based on the movements of the uninjured hand. In the other cases the normal rates given by the Committee of Medical Rating and Physical Impairement (J.A.M.A. spec. ed. febr. 15.1958) have been used in comparison. According to this rating, and in order to measure the function of the wrist, the lasting impairment has been judged without taking into consideration the patient's subjective troubles. The following movements have been measured: Dorsal, volar, radial and ulnar flexion, pronation and supination. These are the results:

0– 5 per cent mobility impairment: eight patients
6–10 per cent mobility impairment: ten patients
11–25 per cent mobility impairment: five patients

*Subjective Symptoms*

Of the thirteen patients in groups I+II three had grumbling in the hand with weather changes and three reported some hypoaesthesia on the dorsum of the thumb. All patients in these groups stated that they had full working ability.

Of the ten patients in groups III+IV one patient had difficulty in

holding heavy things in maximal pronation and minimal supination of the hand. This patient presented fracture and nerve injury at the time of injury.

One patient, a waitress, reported that she was unable to carry trays with her hand in supination, although she had full mobility in the hand. In two cases, minor sensory nerve disturbances were observed on the dorsal side of the thumb.

One patient complained about lasting pains in the injured wrist, caused by arthritis and arthrosis. This patient, sixty-one years of age, has a full time job as a cashier. The other patients consider their minor defects to be of no importance and are all consequently fully employed.

On the whole, twenty-one patients are very well pleased with the results obtained, and consider their hands to be as good as before the injury. Only two patients do not belong to this satisfied group, namely the one who has certain difficulties in performing her job as a waitress, and one who is not satisfied because of pains.

## DISCUSSION

The above cases, with a few exceptions, represent severe and complicated fractures, which have all healed with satisfactory functional results, despite proved or indicated unsatisfactory results from earlier treatment.

The technically difficult method demands, however, both experience and skill from the operator.

Operations of this kind are specially difficult to perform between two and six weeks after the time of injury because of the fragility of decalcinated bone, or, in other words, when indications clearly show the necessity for operation. Case determination and operating performance at an earlier stage will, however, reduce the degree of difficulty and save the patient's time. These are our general remarks concerning the conditions which, in our opinion, should be taken into consideration:

The stability of a fracture in the lower end of the radius of an unloaded arm is based upon

A. The muscles and their acting on the fragments.
B. The fracture plane's angle to the axis of the radius, which influences the leverage of the muscles.

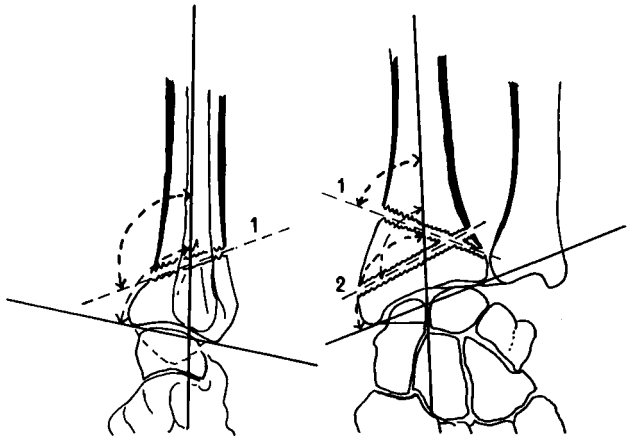


*Figure 2. Drawing of a radial fracture: In case of fractures with fracture line 1, the action of the pronator muscles, especially the quadratus, may draw the scapus fragment towards ulnae, while the distal fragment, tangenting ulnae at the distal radio-ulnar joint, remains in situ, turning only a few degrees around the dorso-ventral axis, thus fracture line 2, the action of the pronators force the scapus fragment to "grasp" the distal fragment, thus helping to keep this in position and to stabilize the fracture.*

The extensor and flexor muscles pull the distal fragment mainly in proximal direction, but to a certain degree also in dorsal or ventral direction according to the position of the hand and the fragments.

The general action of the pronators and supinators, in relation to the movements of the hand and forearm, is well known. Less considered, however, is the action of the pronator quadratus, and to a certain degree the action of the pronator teres, which both try to pull the scapus fragment of the radius towards ulnae. The result of this action is of great importance to the stability of the fracture:

A 90° or more angulation of the fracture line, in frontal view, increases stability, while a smaller angle reduces stability. On the above outline (Figure 2) of a Colles' fracture, fracture line no. 1 of the frontal view shows that the scapus fragment may be drawn ulnar until its distal ulnar corner contacts ulnae, while the distal fragment tangenting ulnae at the distal radio-ulnar joint remains in position, turning only a few degrees around the dorso-ventral axis. The dislocated fracture seems, in other words, to be a radial displacement of the distal fragment, while it actually is an ulnar displacement of the proximal fragment.

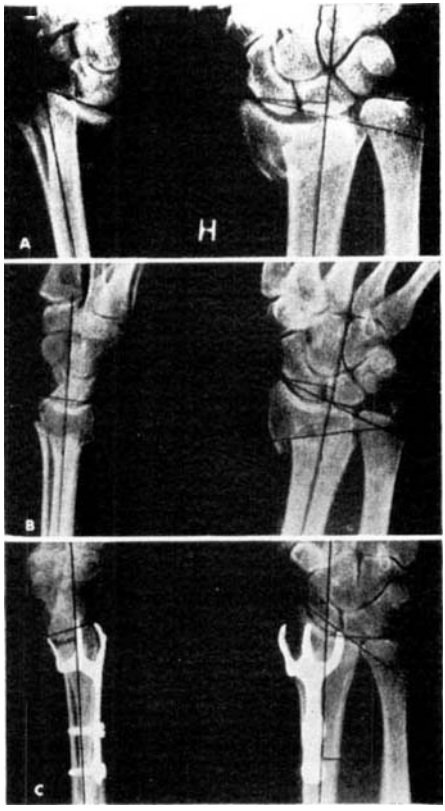


*Figure 3A. A typical Colles' fracture, case no. 14.*

*Figure 3B. The result after three weeks of treatment in a plaster cast.*

*Figure 3C. The final result.*

Fracture line no. 2 shows clearly how the proximal fragment will contact the distal fragment and keep this in position.

The lateral view of the fracture indicates how an angle of more than 90° facilitates a displacement of the distal fragment in the dorsal direction. In the same way, an angle less than 90° lightens a displacement in the ventral direction.

A rough fracture surface will of course increase the friction, but the stability of a fracture depends first of all on the size of the crossed zone of bone. This is usually wedge-shaped, with the base on the dorsal side and the edge on the ventral side, a shape due to the direction of the injury and to the thin, crisp cortical layer on the dorsal side. The thick, strong cortical layer on the ventral side, however, usually prevents the distal fragment from being impacted in the proximal one, which occurs quite often on the dorsal side.

On the whole one may say that the resorbtion of bone increases with

the size and destruction of the crossed zone of bone, resulting in a shortening of the radius and leading to the well known malunions.

As resorbtion seems to increase with the patient's age, we have found it wise to limit the application of our method to patients under sixty-five years, in order to avoid the risk of excessive reabsorbtion of grafts.

The material is of course too limited to draw exact directions for the operative treatment, but it indicates that patients under sixty-five years, and with typical Colles' fractures, should be operated upon when X-ray pictures show that the crossed zone of bone has a base of 1 cm or more. Patients should also be operated upon when the crossed zone of bone is five to ten mm if the frontal view of the fracture line forms an acute angle and the lateral view an obtuse angle to the axis.

It is of course difficult to determine the size of the crossed zone and the angulation of fracture lines by pre-reduction x-ray pictures. Analysis ought therefore to be made after reduction. In our opinion, the old topic of discussion, namely application of plaster casts to or above the elbow, with a more or less pronation or supination of the hand, is of little or no relevance at all in preventing redisplacement of fractures of this type. The only way to prevent shortening of the radius seems to be substitution by bone grafts.

As a consequence, the K-method has been developed, based on grafts of cancellous bone from the iliac crest (without the cortical layer), combined with the application of a special hand-shaped vitallium splint for internal fixation of the fragments.

The reported results of the above-mentioned twenty-six cases justify, in our opinion, further work with the method.

One case is illustrated.

Female, fifty-three years of age, case no. 14, had a typical Colles' fracture with dorsal and radial dislocation, dorsal impaction, and a fracture line with an acute angle to the axis in frontal view and an obtuse angle in lateral view (Figure 3 A). A three week treatment in a plaster cast resulted in a redisplacement (Figure 3 B).

The patient was operated upon twenty-one days after injury, and Figure 5 C shows the final anatomical result.

## SUMMARY

This article describes a method developed to prevent or correct final deformity of the radius after fracture injuries. The method is based on the principle of restoring the anatomical conditions by bone graft-

ing, combined with an internal fixation of fragments by means of a specially constructed vitallium appliance, called the K-splint.

Twenty-six patients have been operated upon according to the above method.

The final results have been evaluated both anatomically and functionally, in seven cases characterized as excellent, in six cases as good, in four cases as fair and in six cases as poor. The approximate functional impairment of the total number of cases is about 7.7 per cent.

The authors of this article conclude that the results achieved through the method described justify further work with the method.


## RESUME

Cet article décrit une méthode élaborés pour prévenir ou corriger une déformité finale du radius après lésion provenant d'une fracture. La méthode se base sur le principe de la restauration des conditions anatomiques par greffe osseuse, combinée à une fixation interne des fragments. au mayen d'un dispositif en vitallium spécialement construit, appelé éclisse K. 26 malades ont été operées par cette methode.

Les résultats finaux ont été caractérisés au double point de vue anatomique et fonctionnel comme excellents dans sept cas, bons dans six cas, passables dans quate cas et mauvais dans six cas. L'affaiblissement fonctionnel a été approximativement de 7.7 per cent si l'on considère le nombre total des cas.

Les auteurs de l'article arrivent à la conclusion que les résultats obtenus par la méthode décrite justifient la poursuite des travaux avec cette méthode.

## ZUSAMMENFASSUNG

Diese Arbeit beschreibt eine Methode, die entwickelt wurde um eine endgültige Deformitet des Radius nach Bruchschäden zu verhindern oder zu korrigieren. Die Methode ist auf dem Prinzip der Wiederherstellung anatomischer Verhältnisse mittels Knochenverpflanzung kombiniert mit einer internen Fixation der Fragmente mittels einer speziell konstruierten Vitalliumschiene, genannt K-Schiene, gegründet. 26 Fälle sind durch diese Methode operiert worden.

Die Endresultate wurden sowohl anatomisch als auch funktionell bewertet und sieben Fälle wurden als ausgezeichnet, sechs Fälle als gut, vier Fälle als mittelmässig und sechs Fälle als schlecht angesehen. Die ungefähre funktionelle Herabsetzung der Gesamtanzahl der Fälle ist 7.7 per cent.

Die Verfasser dieser Arbeit schliessen, dass die mit der beschriebenen Methode erreichten Ergebnisse weitere Verwendung der Methode rechtferigen.

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