Complications of Colles' Fractures*

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ABSTRACT: Patients with Colles' fractures have serious complications more frequently than is generally appreciated. A study of 565 fractures revealed 177 (31 per cent) with such complications as persistent neuropathies of the median, ulnar, or radial nerves (forty-five cases), radiocarpal or radio-ulnar arthrosis (thirty-seven cases), and malposition-malunion (thirty cases). Other complications included tendon ruptures (seven), unrecognized associated injuries (twelve), Volkman's ischemia (four cases), finger stiffness (nine cases), and shoulder-hand syndrome (twenty cases). In many patients, incomplete restoration of radial length or secondary loss of the reduction position caused the complications.

Current opinion seems to be that there are no important problems relating to the treatment of Colles' fractures, despite admonitions that many patients who have had such a fracture are found to have permanent disability and poor function of the hand and wrist. In our hospitals, we have seen a steady flow of complications which has significantly sharpened our awareness of the many difficulties associated with treatment. These difficulties are not commonly appreciated. In the present study of patients referred to us for early and late management, we have accumulated sufficient material to report figures on the incidence of complications from Colles' fracture. Treatment of these complications is a separate consideration that will not be discussed or analyzed, except in delineating a general approach to a specific complication.

Clinical Material

All patients treated for Colles' fractures at the Mayo Clinic from January 1968 through December 1975 were studied. There was a total of 565 patients. Of these, 356 (63 per cent) were seen primarily at our hospitals for treatment of the Colles fracture, while the others were referred for evaluation and treatment because of complications, either early (during the acute treatment of the fracture) or late (with specific complications). All patients who were referred had had primary treatment of the fracture elsewhere, and any patient with a recognized complication who was sent to us for treatment was also considered to be a referral. The case histories, roentgenograms, and follow-up data on all 565 patients were assessed with respect to the mechanism of the injury and associated injuries.

In evaluating and tabulating the results (Table I), we used the Frykman classification of the fracture. Type I was an extra-articular radial fracture; Type II, an extra-articular radial fracture plus an ulnar fracture; Type III, a fracture into the radiocarpal joint; and Type IV, a fracture into the radiocarpal joint plus an ulnar fracture. Type V was a fracture into the radio-ulnar joint; Type VI, a fracture into the radio-ulnar joint plus an ulnar fracture; Type VII, a fracture into both joints; and Type VIII, a fracture into both joints plus an ulnar fracture.

When there were complications, we especially studied the method of reduction, the anesthesia, the type of immobilization, and the post-fracture care, and we tried to correlate each with the type of complication.

Observations

In the total of 565 cases, there were 177 serious complications in 128 patients, as categorized into these eight major types: compression neuropathy (forty-five cases), arthrosis after fracture (thirty-seven cases), malunion after loss of reduction (thirty cases), tendon rupture (seven cases), unrecognized associated injuries (twelve cases), complications of fixation (thirteen cases), Volkman's ischemic contracture (four cases), arthrofibrosis of the fingers (nine cases), and shoulder-hand syndrome (upper-limb dystrophy) (twenty cases).

Some patients had more than one complication. Patients with shoulder-hand syndrome often had two or more presenting complications that contributed to the dystrophy. A tenth complication, early loss of reduction (forty-one cases), was not included in the analysis, except to record its occurrence when it produced a symptomatic arthrosis or malunion.

Minor complications were not recorded in this study. They included transitory radial and median neuritis; flexor and extensor tendinitis; cast-pressure sores; pin-site irritation; and stiffness of the wrist, elbow, and shoulder joints. Conservative treatment, applied early, relieved most of these minor complications.

Complications were encountered whatever the form of fracture treatment used. Among the 356 patients who were primarily treated at our institution, sixty-eight pa-
Compressive Neuropathy

This was the most frequent single complication (7.9 per cent), occurring in twenty-one patients treated locally and in twenty-four who were referred to us for treatment. It was observed both acutely and late after the injury had occurred. Median neuropathy developed early in thirty-one patients, usually associated with reduction of the fracture in the emergency room under local anesthesia (twenty patients). This complication was less frequent after brachial block or general anesthesia (eleven patients). Radial neuropathy, attributable to improper immobilization (cast compression at the spiral groove of the humerus or on the dorsum of the hand), was diagnosed in three patients. Irritation from external pin fixation caused a severe radial neuropathy in two patients. Ulnar neuropathy occurred in six patients as a result of cast compression. All but five of the early neuropathies required no treatment and resolved after the offending compressing agent (cast or pin) was removed. The five exceptions were patients who had a neuropathy as a result of initial injury. They had immediate carpal-tunnel release and no permanent sequelae.

Late neuropathy of the median nerve occurred in forty-one patients. All had persistent symptoms. In four additional patients, the median neuropathy was combined with ulnar neuropathy. There were no late radial neuropathies. Thirty-one of the forty-five patients required release of the carpal tunnel or Guyon's canal, or both, and extensive exploration through an appropriate palmar or forearm incision was essential for adequate decompression (Fig. 1). In six patients, volar fracture fragments were found compressing both the ulnar and median nerves and were removed. Excessive callus formation (seven patients), persistent hematoma (six patients), and localized swelling (twelve patients), usually the result of the forced volar flexion-ulnar deviation position (Cotton-Loder), were considered to be responsible for most of the other late neuropathies. Eleven of the twenty-four patients who were referred to us and seven of the twenty-one treated primarily had one additional complication associated with a compressive neuropathy, and one referral patient had three associated complications.

Arthrosis after Fracture

When either painful motion of the wrist or forearm was evident or there was a mechanical obstruction to motion after fracture, we diagnosed the condition as arthrosis. It was observed in thirty-seven patients and represented 20 per cent of the complications. Radio-ulnar arthrosis (twenty-seven patients) was more common than radiocarpal arthrosis (ten patients). Frykman Type-VI, VII, and VIII fractures most often elicited this complication. When external pin-fixation techniques that restored

### Table I

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<th>Frykman Type</th>
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the radial length were used to treat those fractures there
was a lower incidence of arthrosis (four patients), despite
the fact that pin fixation was the preferred treatment for the
more comminuted fractures.

Of the ten patients with radiocarpal arthrosis, nine
were treated surgically: three by dorsal osteotomy, two by
proximal row carpectomy, two by arthrodesis, and two by
total prosthetic arthroplasty of the wrist. Of the twenty-
seven patients with radio-ulnar arthrosis, nineteen had a
painful radio-ulnar joint that required a Darrach resection
of the distal end of the ulna (fourteen patients), a Milch
procedure (one patient), or a Silastic replacement arthro-
plasty (four patients). Six other patients had symptomatic
radio-ulnar subluxation with a mechanical obstruction to
motion and required Darrach excision of the distal end
of the ulna. All twenty of the patients who had the Darrach
procedure had improvement in motion of the wrist and, in
particular, in pronation and supination of the forearm.

Ten of the twenty-one referral patients and seven of
the sixteen primary patients had an additional complica-
Malposition-Malunion

Thirty patients had this complication, the majority
having been referred for treatment. Five patients had frac-
tures that were not yet fully united when they were seen for
treatment. They required early open reduction. The other
twenty-five patients required osteotomy. Malunion was
most commonly related to loss of the reduction position,
which commonly occurs when the fracture is unstable and
communited. This loss of reduction early in the treatment
period was a frequent problem. In this series, treatment for
loss of reduction was required in 27 per cent of the 565
patients. A corrective reduction was usually performed by
distraction and gentle manipulation, the patient having had
brachial block or general anesthesia. It was successful in
most patients (more than 92 per cent) when accomplished
within two weeks of the fracture and when the reduction
was maintained with some form of external pin fixation.
Our preference was to insert in the base of the second and
third metacarpals two 2.0-millimeter (5/64-inch) Stein-
mann pins oriented at 60 to 90 degrees to each other. Two
slightly larger pins (2.3 millimeters, 3/32 inch) were
placed in the middle third of the radius. A Roger Anderson
external-fixation apparatus attached to these pins main-
tained the reduction and provided stabilization. Additional
pins or Kirschner wires were used, as required, to secure
loose fragments. When the pins applied above and below
were inadequate to maintain reduction open reduction was
done (five patients), with satisfactory results.

After inadequate treatment of the fresh fracture was
followed by malunion, the complaints of significant pain,
deformity, and limitation of motion present in twenty-five
patients led to recommendations for corrective osteotomy.
Fourteen patients had that operation at our institution.
Three patients accepted the deformity or preferred not to
have surgery, and six had the operation in their home
community. Two were lost to follow-up. In most of our
fourteen patients the corrective osteotomy was supplemen-
ted by bone-grafting (Figs. 2-A through 2-D). Improve-
ment in grip strength and motion was achieved in all but
one of these fourteen patients, and that patient required ar-
throdesis.

Nine of the referral patients in this group had an
additional complication, as did one of the twelve primary
patients. Two referral patients had two additional compli-
cations.

Tendon Rupture

Rupture of the extensor pollicis longus was noted in
five patients, and rupture of the index flexor digitorum
profundus or flexor pollicis longus was noted in one patient
each. The rupture was primarily related to bone fragments
from displaced fractures that abraded the tendon during the
weeks after healing of the fracture. All five patients with
loss of the extensor pollicis longus tendon had rupture
within two months from the initial injury (two, two, three,
four, and eight weeks), while in the two patients with
flexor tendon rupture the rupture occurred after three
months. All patients had either a tendon transfer or a ten-
don graft. Direct tendon repair was not possible because
several centimeters of tendon substance had been lost.

Associated Injuries Unrecognized Primarily

These included scaphoid fractures (four patients),
radial head fractures (two patients), Bennett's fracture
(one patient), and intercarpal ligament injuries (five pa-
tients), which were recognized between two days and one
month from the time of the original injury. These injuries
usually were caused by the same mechanism that caused
the Colles fracture. In our series, ligament instability of
the wrist required operative reconstruction of the
scapholunate ligament in four patients. Scaphoid fractures
required open reduction in two patients, and radial head
fractures required excision of the radial head in two pa-
tients.

Complications of Fixation

Three patients with pin fixation had pin breakage that
required operative removal of the pins. Pin loosening
with purulent drainage occurred in eight patients, and an ulcer-
ation of the area around a pin occurred in one patient. One
patient sustained a fracture through the pin site in the distal
end of the radius. Two patients had nerve irritation caused
by the cast, which led to sympathetic dystrophy (as will be
discussed). Casts caused other complications, as described
in the paragraphs on compressive neuropathies, Volk-
mann's ischemia, and shoulder-hand syndrome.

Volkman’s Ischemic Contracture

This was seen in four referral patients, three of whom
had had a constricting cast that was retained despite the
patient's complaints of persisting pain. Continued use of
analgesics in two patients further masked the symptoms.
Median neuropathy associated with Colles' fracture may involve a prominent volar callus, which in this patient compressed the median nerve proximal to the carpal tunnel. Surgical release was extended into the distal end of the forearm to ensure adequate decompression.

One of the three patients had had an undisplaced fracture.

Our treatment of these patients was difficult and prolonged. We variably used nerve and muscle decompression, lysis of tendons and nerves, release or lengthening of muscle-tendon units, and tendon transfers when indicated, and the long-term results in three patients were only fair. The fourth patient had persistent pain and finally had to have a below-the-elbow amputation.

Shoulder-Hand Syndrome

This is more appropriately called upper-limb dystrophy or pain-dysfunction, and was a significant problem in twenty patients, sixteen of whom had been referred. Four patients had acute symptoms with predominant sympathetic components of change in skin temperature, color, and texture; pain and loss of motion in the shoulder; and stiffness of the hand or specific local trigger areas of exquisite pain and tenderness (or both). In one patient it was the result of radial-nerve irritation from pin fixation; in two patients, from excessive wrist flexion which produced acute median neuropathy; and in one, from an unreduced, severely displaced fracture with associated disuse of the limb. Two of the four patients had one other complication and two had two additional complications.

The sixteen referral patients had late upper-limb dystrophy. They had fewer sympathetic components than did the patients with the acute condition, but had long-established clinical complaints of stiffness and disuse of the shoulder, stiffness of the hand, painful motion, carpal tunnel symptoms, and radiocarpal arthrosis. Ten of the sixteen patients had fracture malunion. Fourteen of them were referred with long-established complaints, but improved on conservative treatment extending for from six
weeks to four months. Six of the sixteen had one other complication and four, two or more complications.

**Stiff Hands**

Stiff hands from arthrofibrosis of the fingers were a severe complication in nine patients. It was manifested by pain and swelling limited to the hand, with a loss of finger motion and occasionally a loss of motion of the wrist. Swelling and pain, particularly in the structures lined with synovial tissue, were the most characteristic findings in seven patients. Swelling of the proximal interphalangeal joint was the major source of pain and resulted in a severe loss of motion. The factor most commonly associated with the clinical symptoms and signs was improper application of a cast. Stiff hands occurred most often after improper cast application (seven of nine patients in this category). A lack of early motion of the hand was evident in five of the nine patients, and pre-existing degenerative arthritis was present in three patients. Three patients had a mild Dupuytren’s contracture in the affected hand. Six of the nine patients had full recovery, and the other three had improved function after conservative treatment.

**Multiple Complications**

A study of the patients who had multiple complications that usually included the shoulder-hand syndrome revealed that the underlying cause of the dystrophy appeared to be a combination of predisposing factors in conjunction with difficulties in treatment, such as repeated attempts at reduction (seven patients), improper immobilization in the cast (four patients), poor mobilization of the joint (eight patients), and inadequate efforts at rehabilitation.

**Discussion**

Severe complications from Colles’ fracture continue to occur frequently. We found that there were more patients than we anticipated whose complications required extensive treatment. Possibly the percentage of complications in this report is higher than in other reports because more than 46 per cent of the patients (sixty of 128) with complications were referred for treatment. We have divided the complications into nine groups, of which the largest was the neuropathies.

Compression neuropathies occurred both early (within the first two weeks) and later during the period of treatment. When the median nerve was involved, early recognition was common. However, in some patients, when the radial or ulnar nerve was compressed, the diagnosis was delayed because the physicians failed to appreciate or suspect that the nerve was compressed, stretched, or irritated. This failure was especially evident when fixation pins were utilized. Delay in diagnosis usually led to complications such as a stiff hand or carpal tunnel syndrome.

Median neuropathy was identified more often in this series of patients than in previously reported series, probably because there is increased recognition of this condition and because more patients are referred for surgi-
that a significant contributor to the neuropathy is the force of fracture reduction and the position of immobilization; the higher frequency of this complication after local block, with or without systemically administered analgesics, tends to support this belief.

Post-fracture arthrosis was the second most common complication in our patients, yet often it went unrecognized for some time. Subtle forms of this arthrosis are responsible for a large portion of the weakness of grip and limited motion that are commonly seen after this fracture. When the condition is recognized, the patient often can be improved by conservative measures, such as splinting, the local injection of steroids, and the use of salicylates. Operative treatment for radiocarpal arthrosis was necessary in only nine patients in our series. The radio-ulnar arthrosis that was seen in twenty-seven patients mostly stemmed from the inability to obtain an adequate anatomical reduction, manifested in two ways. One was malalignment of the sigmoid notch of the distal end of the radius with the ulnar head, owing to radial deviation and dorsiflexion of the distal radial component. The other was inadequate restoration of length to maintain the normal relationship of the radio-ulnar joint. This problem was significant enough to require surgical treatment in nineteen of the twenty-seven patients. We believe that the common technique of reduction and immobilization in full pronation with ulnar deviation so that the distal end of the ulna provides stability is mechanically unsound, particularly in displaced, highly comminuted fractures. The distal radio-ulnar joint often is unstable, and any radio-ulnar subluxation or dislocation that exists is only increased by immobilizing the hand in full pronation. The end result may be that rotation of the forearm, especially supination, becomes severely limited.

We agree with Sarmiento et al., and others, that the best position for maintaining normal alignment and minimizing deforming forces is supination. When the proper length of the distal end of the radius is difficult to maintain, strong, protracted traction and external pin fixation may be the best form of treatment.

Early loss of reduction and late collapse after Colles’ fracture probably are two common complications that are too readily accepted by treating physicians. To us, each of these conditions signifies that the fracture being treated is unstable. It usually has one or more of the following characteristics: extensive comminution, marked displacement of fragments, or interposition of soft tissue — and any one of them can lead to an incomplete reduction. We believe that whenever a fracture is unstable, no amount of residual dorsal angulation after reduction is permissible. Adequate reduction requires that the full dorsal length of the radius be restored and maintained. This requires a stable volar buttress plus dorsal tension by tissue or an apparatus that prevents dorsal collapse. Otherwise the force of active finger flexor and extensor tendons, combined with dorsal translation of the lunate, tends to produce a proximal carpal thrust that results in a dorsal compressive force leading to collapse and displacement.

Present methods of fracture reduction and cast support do not always prevent these potentially deforming forces, particularly in comminuted fractures. In unstable fractures, we prefer to use external pin fixation in order to maintain a distracting force, prevent collapse, and allow the volar fragments of the cortex to unite in good position. We have used this method for patients in whom reduction of the fracture was lost after cast immobilization and also for potentially unstable intra-articular fractures (Frykman Types V through VIII), and have achieved satisfactory results.

Open reduction of Colles’ fracture is rarely advocated, despite the need for accurate reduction of the fracture. Because the functional results so closely parallel the anatomical results, it is our practice that when closed reduction, including the use of external pin fixation, is not successful, open reduction is indicated. Definite criteria for open reduction of Colles’ fractures have not been completely formulated, but for the present the technique should be more strongly considered for use in young adults in whom comminuted, unstable intra-articular fractures have been treated unsuccessfully by closed reduction techniques.

The incidence of complications from Colles’ fractures reported here does not differ significantly from the types and frequency of problems reported by others. Frykman noted the significant sequelae of radio-ulnar arthrosis (18.6 per cent), shoulder-hand syndrome (2 per cent), and peripheral neuropathy (3.5 per cent) in his series of 430 cases. He found that symptoms at the distal radio-ulnar joint were most frequently related to fractures into the joint (41 per cent) combined with dorsal angulation and shortening of the distal end of the radius. Lippman and Lidström had similar findings (10 per cent and 15 per cent incidences of radio-ulnar arthrosis, respectively) and stressed that radio-ulnar instability was the most common cause of a poor result. Gartland and Werley reported an incidence of arthrosis of 22 per cent. In combining both radiocarpal and radio-ulnar arthroses, we found symptoms that were significant enough to require surgical treatment in thirty-seven (6.5 per cent) of 526 patients.

Shoulder-hand syndrome was present in 1.4 per cent of patients reviewed by Bacorn and Kurtzke, in 3.4 per cent in Rosen’s series, and in 10 per cent in Lidström’s series of 515 patients. The latter included finger-joint stiffness and Südeck’s atrophy. Unsatisfactory results were reported in 67 per cent. The incidence in our series was four (1.1 per cent) of 356 local patients. While affected patients are fewer in number, this complication is the most difficult to treat, and prevention by the techniques described by Moberg should be studied.

Peripheral neuropathy as a serious complication was not noted by others to be as frequent as we have reported it to be (forty-five patients over-all and twenty-one [3.7 per cent] of patients who were primarily under our care).
Lidström believed that nerve injuries are rare after fractures of the distal end of the radius (slightly more than 1 per cent). Bacorn and Kurtzke reported an incident of 0.2 per cent and Schlesinger and Liss noted only one case per 1,000 fractures. We believe that these negative reports were due in part to a lack of recognition and possibly more concern with treatment of the fracture than with potential sequelae. Lynch and Lipscomb, Frykman, Robbins, and others have placed proper emphasis on the causes of median neuropathy and the need for aggressive treatment in certain acute as well as late cases.

Complications related to more than one factor were common whenever three complications — neuropathy, arthrosis, and shoulder-hand syndrome — were present. Frykman found that of eighty patients with radio-ulnar arthrosis, five (6.3 per cent) had median neuropathy and five had shoulder-hand syndrome. Of our twenty patients with shoulder-hand syndrome, sixteen had one or more associated complications (arthrosis in ten patients, median neuropathy in nine patients, malunion in ten patients, and sympathetic dystrophy in five patients). Evidently, these complications and others contribute directly to the 24 to 27 per cent incidence of poor functional results that has been reported from the treatment of Colles' fractures.

References