

Colles' Fractures: Functional Treatment in Supination

Collesova zlomenina: funkční léčení v supinaci

A. SARMIENTO, L. L. LATTA

Department of Orthopedic and Rehabilitation University of Miami, Florida, USA

ABSTRACT

PURPOSE OF THE STUDY

Abraham Colles classified and described fractures of the distal epiphyseal radius. He recommended the arm should be immobilized in a cast that extends from the base of the fingers to above the elbow, while holding this joint at ninety degrees of flexion the forearm in pronation and the wrist in slight flexion and ulnar deviation. We identified the brachioradialis muscle as the main culprit in the frequently observed loss of reduction of the fracture. Since the brachioradialis is attached to the distal region of the radius and functions as a flexor of the elbow when the forearm is in pronation, its stimulation easily displaces a reduced fracture, particularly if its geometry suggests axial instability. We concluded that post-reduction stabilization in supination was more desirable than in pronation.

MATERIAL AND METHODS

Prospective study of one hundred and fifty-six patients suffering from Colles' fractures who were treated with the functional method. Approximately one-half of the fractures were immobilized in pronation and the other half in supination. The median age of the patients was 49 years. After approximately eleven days of immobilization in an above-the-elbow cast that held the forearm in a relaxed attitude of supination and the wrist in slight flexion and ulnar deviation, a new cast or brace was applied. The appliance permitted flexion of the elbow and slightly limited extension. We utilized modified Lindstrom criteria to assess radiological results, according to types of fractures and by groups treated in supination and pronation.

RESULTS

In the type I and III (non-displaced) fracture series there appeared to be no significant difference in the functional results between the pronation and supination treated groups. In the type II category, in the supinated fractures, there were 9 excellent, 4 good and no fair or poor results. In the pronated group 9 excellent, 8 good and one fair result. The functional results in type IV fractures treated in supination were excellent in 11 instances, good in 7 and fair in 2. In fractures treated in pronation there were 5 excellent, 10 good and 5 fair results. There were no poor results in either group. 85% of type II fractures and 85% of type IV fractures treated in supination had excellent or good results. In the pronation group, 67% had excellent or good results in type II and 40% in type IV classification. In combining the results for all types of braced Colles' fractures, (I–IV) 93% of the supination group and 87% of the pronation group achieved excellent or good functional results. In analyzing overall results regardless of type of fracture or position of immobilization, 90% of the patients had excellent or good results.

CONCLUSION

We treated Colles' fractures in supination and compared the results with those obtained when treated in pronation. The results indicated a lower incidence of re-displacement in the supination group. We developed a forearm brace that permits flexion of the elbow, but prevented pronation of the forearm, and limited extension of the elbow in approximately the last fifteen degrees. It permits minimally limited flexion of the wrist but prevents wrist dorsiflexion. It makes impossible any radial deviation. The place of surgery in the management of Colles' fractures should be limited to those fractures that when treated by non-surgical means are not likely to render satisfactory functional and cosmetic results. There is not at this time a consensus as to when to use the surgical approach. The complication rate from the surgery have not clearly identify superiority of one over the other. Nonetheless, the surgical treatment has a definite place in the armamentarium of the orthopaedic surgeon. In a number of situations, it is the treatment of choice.

Key words: Colles' fractures, conservative treatment, supination, surgical treatment.

INTRODUCTION

Ever since Abraham Colles classified and described fractures of the distal epiphyseal radius, his ideas have guided the thinking about these fractures and their management. He recommended that following manual reduction of the fracture, the arm should be immobilized in a cast that extends from the base of the fingers to above the elbow, while holding this joint at ninety degrees of flexion, the forearm in pronation and the wrist in slight flexion and ulnar deviation. Despite the inevitable development of complications that accompanies all treatment modalities, the overall results have been gratifying. Millions of people over the years have enjoyed a residual painless joint and in most instances a functional wrist.

As surgical techniques in the management of other fractures improved, recent attempts to obtain anatomical reduction and elimination of articular incongruity by surgical means have been popularized. It is perhaps too early to cast final judgment on the place and role of surgery, versus conservative treatment of these fractures. Nonetheless, there is sufficient data to support the concept that certain Colles' fractures are best treated surgically with the use of immobilizing metallic plates (11).

After carefully observing the radiological findings of a large number of Colles' fractures, as well as anatomical dissections and electromyographic studies, we concluded that post-reduction stabilization in supination was more desirable than in pronation. We identified the brachioradialis muscle as the main culprit in the frequently observed loss of reduction of the fracture (Figs 1 and 2). Since the brachioradialis is attached to the distal region of the radius and functions as a flexor of the elbow when the forearm is in pronation, we documented the fact that its stimulation easily displaces

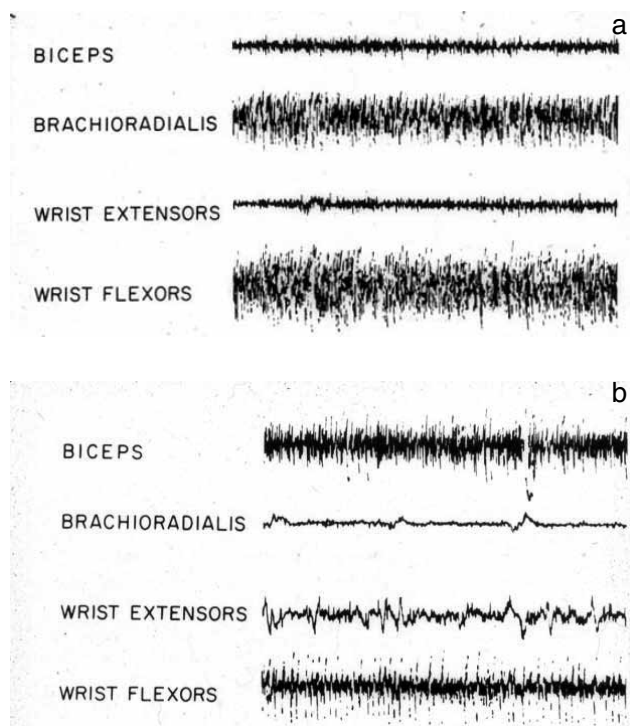


Fig. 1. Electromyographic study demonstrating that: a – if the forearm is in pronation and the elbow is actively flexed, the function of the biceps is minimal, but that of the brachioradialis is maximal, b – if the elbow is actively flexed while the elbow is in supination the biceps shows maximal contraction and the brachioradialis remains quiet.

a reduced fracture, particularly if its geometry suggests axial instability (7, 9, 10).

These observations led us to develop first a cast that allows the elbow to flex to more than one-hundred degrees, but its extension is limited in the last 25 to thirty degrees.

MATERIAL AND METHOD

We conducted a prospective study of one hundred and fifty-six patients suffering from Colles' fractures who were treated with the functional method (10). The subsequent results have been published in the orthopaedic literature (2, 3, 8–10). Approximately one-half of the fractures were immobilized in pronation and the other half in supination. The median age of the patients was 49 years.

The cast applied following the initial reduction is a circular one that holds the elbow at ninety degrees of flexion, the forearm in supination and the wrist in moderate flexion and ulnar deviation (Fig. 3).

At approximately one week after the initial treatment the cast is replaced with either a functional cast or a functional brace. They permit limited motion of the elbow to minus 15–20 degrees of flexion to minus twenty degrees of extension. This limitation of motion



Fig. 2. Schematic drawing of a comminuted fracture illustrating the pull of the brachioradialis muscle and the resulting collapse of the radial fracture.



Fig. 3. The cast applied after the initial reduction holds the elbow at 90 degrees of flexion, the forearm in supination and the wrist in a few degrees of flexion and ulnar deviation.



Fig. 4. a – the forearm is flattened, b – the cast is extended over the distal arm while holding the elbow at 90 degrees and the forearm in supination, the supracondylar area is firmly compressed, c – the anterior wall of the cast is removed to make possible flexion of the elbow, while preventing full extension of the elbow, d – notice the firm compression of the supracondylar area.

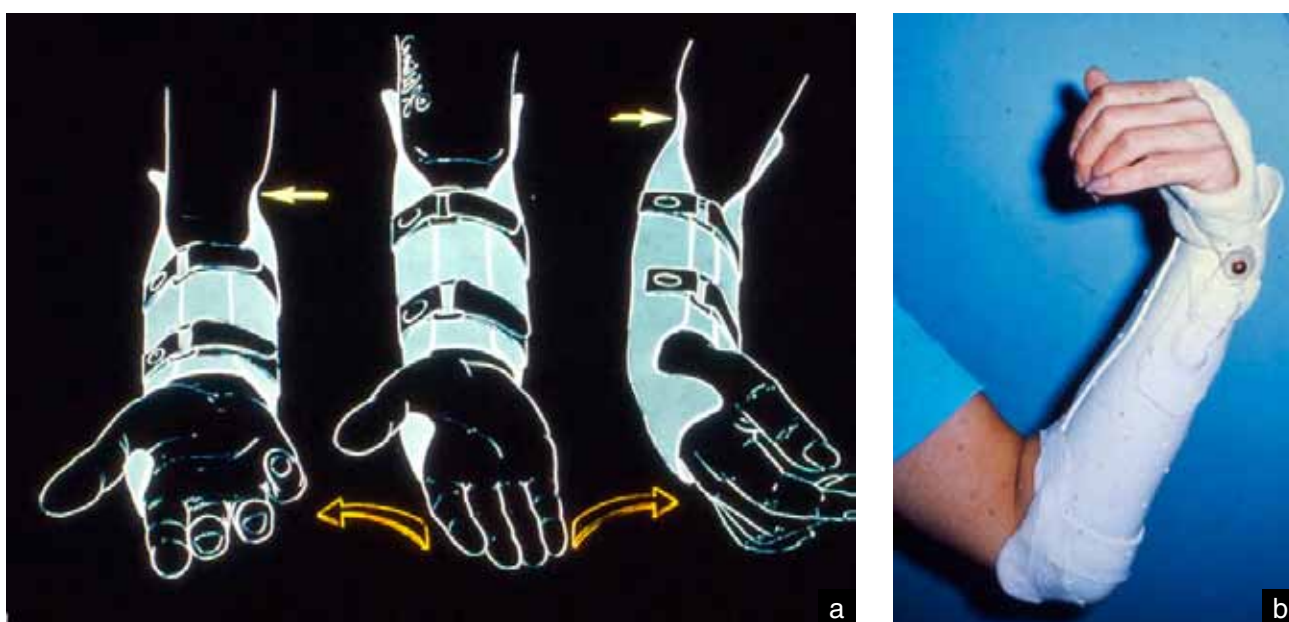


Fig. 5. a – schematic drawing of the functional brace and the manner in which pronosupination is prevented, b – plastic functional brace illustrating the metallic joint that allows for flexion of the wrist while preventing dorsiflexion and lateral motions.

is made possible by the careful molding of the cast over the humeral condyles (Fig. 4).

When plastic material or prefabricated braces are used, the same basic principles are sustained. Mechanical joints are attached to the body of the brace.

After approximately eleven days of immobilization in an above-the-elbow cast that held the forearm in a relaxed attitude of supination and the wrist in slight flexion and ulnar deviation, a new cast or brace was applied. The appliance permitted flexion of the elbow and slightly limited extension.

We utilized modified Lindstrom criteria to assess radiological results, according to types of fractures (I to IV) and by groups treated in supination and pronation.

RESULTS

Twenty-three (15%) fractures fell within category I; 44 (28%) in category II; 40 (26%) in category III; and 49 (31%) in category IV. Ninety-three fractures were displaced and 63 were non-displaced.

For types I and III (non-displaced fractures), there was no significant change in position of the fracture from the time of injury to the last follow-up, regardless of whether braced in pronation or supination.

In the displaced fractures (Types II and IV) we observed the following. From bracing to first follow-up in type II fractures (displaced, extra-articular) treated in supination, only one patient lost radial length representing 8% of the group, while 7 of those treated in pronation showed at least two millimeters (39%). None of the supination patients experienced any further loss of volar tilt once braced. However, 3 (17%) patients in the pronation category had further dorsal angulation of at least 2 degrees. There was no appreciable difference between the groups with regard to radial deviation.

In patients with Type IV fractures (intra-articular, displaced) there was no significant difference in respect to radial displacement. However, in analyzing radial length and volar tilt, we found that the overall results in the pronation group were inferior to those in the supination group.

After bracing in supination, one (5%) of the total group of patients lost 2 degrees of volar tilt, whereas 10 (50%) patients in the pronated group angulated 2 degrees or more while in the brace.

In the type I and III (non-displaced) fracture series there appeared to be no significant difference in the functional results between the pronation and supination treated groups. In the type II category, in the supinated fractures, there were 9 excellent, 4 good and no fair or poor results. In the pronated group 9 excellent, 8 good and one fair result. All fractures in the type II category with excellent anatomical results had excellent functional results.

The functional results in type IV fractures treated in supination were excellent in 11 instances, good in 7 and fair in 2. In fractures treated in pronation there were 5 excellent, 10 good and 5 fair results. As with type II fractures, all type IV fractures which had excellent anatomical results had excellent functional results. There were no poor results in either group.



Fig. 6. Photo of patient being treated with plastic functional braces with metallic wrist joints.

85% of type II fractures and 85% of type IV fractures treated in supination had excellent or good results. In the pronation group, 67% had excellent or good results in type II and 40% in type IV classification.

In combining the results for all types of braced Colles' fractures, (I–IV) 93% of the supination group and 87% of the pronation group achieved excellent or good functional results.

In analyzing our overall results regardless of type of fracture or position of immobilization, 90% of the patients had excellent or good results.

DISCUSSION AND RECOMMENDATIONS

Solid data have indicated that the brachioradialis muscle plays a major role in the recurrence of deformity when the forearm is stabilized in pronation and that the incidence of recurrence of deformity decreases when the forearm is stabilized in supination, indicating that patients treated in supination have a superior anatomical result.

We treated Colles' fractures in supination and compared the results with those obtained when treated in pronation. The results indicated a lower incidence of re-displacement in the supination group. We developed a forearm brace that permits flexion of the elbow, but prevented pronation of the forearm, and limited extension of the elbow in approximately the last fifteen degrees. It permits minimally limited flexion of the wrist but prevents wrist dorsiflexion. It makes impossible any radial deviation (2, 9, 10).

The place of surgery in the management of Colles' fractures should be limited to those fractures that when treated by non-surgical means are not likely to render satisfactory functional and cosmetic results.

Any concerns about secondary osteoarthritis due to residual incongruity must be objectively assessed. Symptomatic osteoarthritis is rare following Colles' fractures whether intraarticular or extraarticular even though some limitation of motion may be present. This is true regardless of their surgical or non-surgical management. If incongruity were to readily lead to arthritis, its incidence

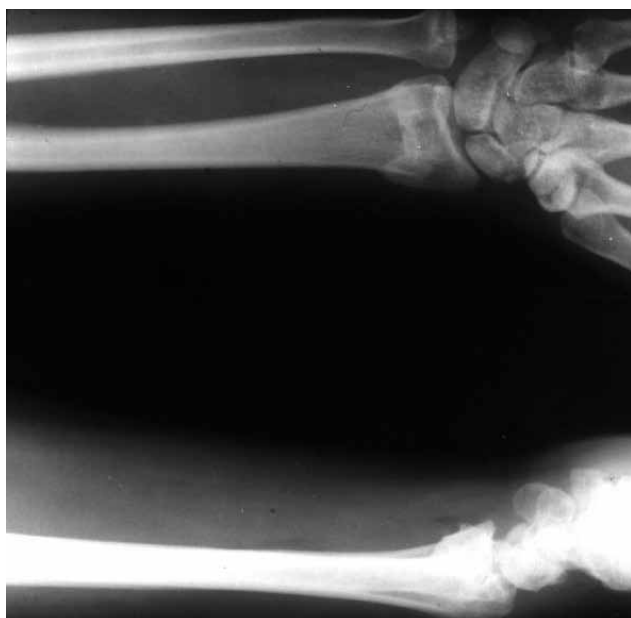


Fig. 7. a – initial radiograph illustrating the severe dorso-lateral displacement of the distal radial fragment, b – long term radiograph showing the restoration of length and alignment and the persistent painless subluxation of the radio-ulnar joint, e-f – patient illustrating the rotation of the forearm and the dorsal and volar motion of the wrist, notice the mild, inconsequential loss of the last few degrees of volar and palmar motion.



a
b
c
d
e
f

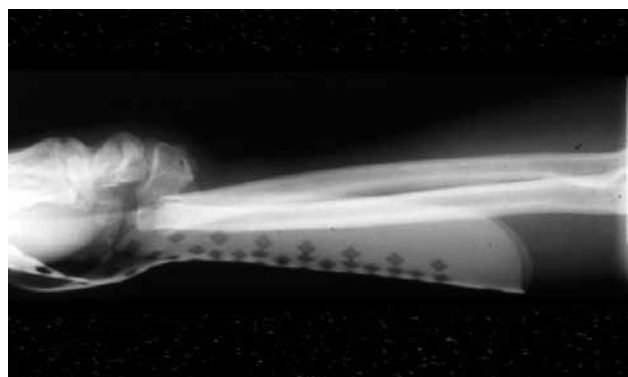
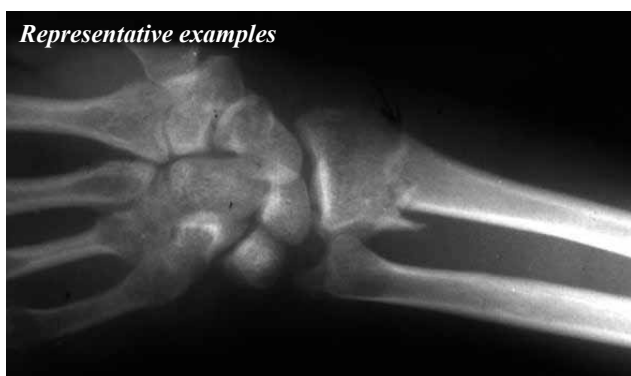


Fig. 8. Illustration of severely displaced Colles' fracture showing the reduction following manipulation and radiological appearance in the plastic brace.

would extremely common, which definitely is not the case. The power of cartilage remodeling has been underestimated having lead to the performance of unnecessary surgery in many instances. Our laboratory work has shown evidence that without perfect anatomical reapproximation of fractured articular cartilage a reparative process begins. The fact that osteoarthritic changes develop in some instances, in the wrist, as well as in fractures in other joints, may be due to other factors, such as initial irreparable damage of the cartilage (1, 4, 5).

CONCLUSION

During the last few decades enthusiasm has grown in support of open reduction and internal fixation of Colles' fracture. The techniques most commonly recommended are cross-pinning and plate fixation, which made possible the attainment of better reduction and restoration of

articular congruity in instances when the comminution and displacement of the fragments is major. It must be kept in mind that ultimate restoration of anatomy following surgery does not necessarily mean normal range of motion. Anecdotally, we have observed that in many instances, regardless of the treatment used – surgical or nonsurgical – a residual limitation of motion, usually of an inconsequential nature is present.

Opinions vary regarding the incidence of osteoarthritic changes resulting from damage to the articular cartilage at the time of the injury (11).

There is not at this time a consensus as to when to use the surgical approach. The complication rate from the two main surgeries have not clearly identify superiority of one over the other (6). Nonetheless, the surgical treatment has a definite place in the armamentarium of the orthopaedic surgeon. In a number of situations, it is the treatment of choice.

References

- BALINT, L., PARK, S. H., BELYEI, A., LUCK, J., SARMIENTO, A., LOVASZ, G.: Repair of steps and gaps in articular cartilage. Clin. Orthop. Relat. Res., 430: 208–212, 2005.
- COLLES, A.: On the fracture of the carpal extremity of the radius. Edinb. Med. Surg. J., 1814; 10: 181. Clin. Orthop. Relat. Res., 445: 5–7, 2006.
- FRYKMAN, G.: Fracture of the distal radius including sequelae. Acta Orthop. Scand., Suppl 108: 3, 1967.
- LLINAS, A., MCKELLOP, H., MARSHALL, J., SHARPE, F., LU, B., KIRCHEN, M., SARMIENTO, A.: Healing and remodeling of articular incongruities in a rabbit fracture model. J. Bone Jt Surg., 75-A: 10: 1508–1523, 1993.
- LOVASZ, G., LLINAS, A., BENYA, P., SARMIENTO, A., LUCK, J.: Cartilage changes caused by a coronal surface step off in a rabbit model. Clin. Orthop. Relat. Res., 354: 224–234, 1998.
- MAPIRE, N., LEBAILTY, F., ZEMIRLINE, A., HARRIS, A., FACCA, S., LIVERMEAUX, P.: Prospective continuous study comparing intrafocal cross-pinning HK2 with a locking plate in distal radius fracture fixation. Chir. Main., 32: 17–24, 2013.
- SARMIENTO, A.: The brachioradialis as a deformity force in Colles' fractures. Clin. Orthop. Relat. Res., 38: 86–92, 1965.
- SARMIENTO, A.: Closed treatment of distal radius fractures. Tech. Orthop., 15: 294–304, 2001.
- SARMIENTO, A., PRATT, G. W., BERRY, N. C., SINCLAIR, W. F.: Colles' fractures: Functional bracing in supination. J. Bone Jt Surg., 57-A: 311–317, 1975.
- SARMIENTO, A., ZAGORSKI, J. B., SINCLAIR, W. F.: Functional bracing of Colles' fractures: A prospective study of immobilization in supination versus pronation. Clin. Orthop. Relat. Res., 146: 175–187, 1980.
- THOMPSON, R. C., OEGEMA, T. R., LEWIS, J. L., WALLACE, L.: Osteoarthrotic changes after acute transarticular load. J. Bone Jt Surg., 73-A: 990–1001, 1991.

Corresponding author:

Prof. Augusto Sarmiento, M.D.
Department of Orthopedic and Rehabilitation
University of Miami, Florida, USA