

Management of Colles' Fracture by Conservative vs Open Reduction Bone Grafting and Internal Fixation with K-wire

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ABSTRACT

Background: Colles' fracture is commonly encountered fracture in emergency department. Majority of cases are being treated by conservative means that often leads to deformity and instability. We compared the treatment outcome of open reduction and bone grafting with conventional close reduction and cast application.

Methods: This prospective study was carried out in two different centers from September 2002 to September 2004. There were 41 patients included in the study. There were 24 patients in conservative group and 17 patients in operative group. All patients were followed up to twelve weeks. At six months follow up only 19 patients were available in conservative group and 16 patients in operative group. We observed anatomical and functional outcome in both groups immediately after reduction, at six weeks, at twelve weeks and at six months.

Results: Reduction can be achieved in both groups but at the final follow up there was significant collapse observed in conservative group. There was a significant improvement in the dorsal angle, radial angle and radial length at six months follow up in operative group. Functional results in terms of pain, range of motion and grip strength were also observed better in operative groups but this difference was not statistically significant. In operative group one case developed non-union and in conservative group two cases developed reflex sympathetic dystrophy.

Conclusion: This study shows that the open reduction and tricortical bone grafting in Colles' fracture treatment gives better anatomical results than in conservative groups. There is no significant difference in function at short term if there is no malunion.

Key words: fracture; open reduction; bone grafting; close reduction

INTRODUCTION

Distal radius fracture is very common, estimated to account for up to 1/6th of all fractures. The incidence of complications, which includes stiffness and loss of reduction, has been reported to be as high as 31%.¹ Despite, our use of more elaborate treatment methods, there are still disabling symptoms of pain, deformity,

stiffness, and nerve compression syndromes associated with distal radial malunion. This fracture is inherently unstable due to comminution of dorsal cortex and tapering shape of the radius. Collapse is inevitable while fracture is healing unless there is good dorsal support. Based on this concept tricortical bone graft was used to fill dorsal comminution and further fixation was done with trans-styloid k-wire. Closed reduction and

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cast immobilization invariably leads to poor functional outcome due to re-displacement of fracture within the cast.² The purpose of the study is to evaluate the results of this technique in fractures of the distal end of radius and to compare it with the results of closed manipulative reduction and plaster cast immobilization. We compared the anatomical and functional outcome of this technique with that of the conventional close reduction and cast application for distal radius fracture.

METHODS

This is prospective comparative clinical trial conducted in the departments of Orthopedics at two different centers from September 2002 to September 2004. After Ethical approval and patient consent 41 patients aged 40 and above with displaced, extra-articular distal radius fractures (Frykman type I and II) having normal contra-lateral wrist were enrolled in this study. These patients were randomly divided into two groups. Twenty four of them were treated conservatively with close reduction followed by below elbow cast for six weeks and other group included 17 patients who underwent open reduction combined with tricortical bone grafting and trans-styloid k-wire fixation. Patients with increased risk of anesthetic hazards were considered for close reduction. All patients came for follow up to 12 weeks. At six months follow up only 19 patients were available in conservative group. Two patients expired of their medical illness and three patients could not be traced. In operative group one patient did not come for follow up.

1. Close reduction and cast immobilization group:

Normal side wrist X-ray wrist was taken for comparison. Reduction was done under general or regional anesthesia with patient in supine position, shoulder was abducted and elbow flexed. Traction was applied to the thumb with counter traction above the elbow. When traction alone was not sufficient to correct then surgeon manipulated by compression. Reduction was ascertained clinically and radiologically. After satisfactory reduction (dorsal angle < 10 degree, radial angle < 5 degree of the normal side and radial shortening < 5mm of normal side.) Colles cast was applied. Check X-ray was performed immediately after reduction. They were followed up in next day in OPD to check for plaster complications and were subsequently followed up weekly for three consecutive weeks. At each follow up, AP and lateral X-ray were done to note early deformity. At six weeks, cast was removed and active range of motion (ROM) exercise of the wrist was started and anatomical and functional outcome was assessed. At 12 weeks pain, deformity, ROM and grip strength was assessed including radiological

assessment. At six months the final evaluation of anatomical and functional outcome was done. The methods of anatomical and functional evaluation are mentioned at the end of this section.

2. Open reduction internal fixation with cortico cancellous bone grafting group.

We followed the original technique described by McBirnie et al.³ All procedures were carried out in the operation theater under general anesthesia. Tricortical bone graft was harvested by a second team from opposite iliac crest. After applying the tourniquet a transverse incision was made on the dorsum of wrist down to the extensor retinaculum at the level of fracture. A longitudinal incision was made in the extensor retinaculum at third extensor compartment. Fracture site was identified and elevated. This left a defect in the dorsal cortex, which was filled by a triangular wedge of cortico-cancellous bone taken from the opposite iliac crest.



Figure 1. AP and lateral view of reduction, tri-cortical bone grafting and trans-styloid K wire fixation

AK-wire was inserted through the radial styloid diagonally across the distal radius engaging the graft and the more proximally the medial cortex of the radius under the guidance of image intensifier (figure 1). Wound was closed in single layer and below elbow cast was applied with wrist in neutral position. Check X ray was made in AP and lateral view immediately after cast application. Patient was discharged on third post operative day after wound inspection.

Intravenous antibiotics were used till patient was in hospital and oral antibiotics for a further seven days. Sutures were removed on 14th post operative day. Weekly follow up for three weeks were done for AP and lateral view X rays. Next follow up was after six weeks when the cast and pins were removed and AP and lateral x-rays were taken. Functional evaluation was also done as in group one. Anatomical and functional evaluation was performed at 12th weeks and finally at six months.

Anatomical evaluation-

All measurements were done by the X-rays method described by Vander Linden. Values were compared with normal wrist.⁴ Shifts measured as difference from normal side.

- a) Dorsal angle in degrees
- b) Dorsal shift in millimeters
- c) Radial angle in degrees
- d) Radial shift in millimeters
- e) Radial length in millimeters

Functional evaluation⁵

Pain:

- Grade I (no pain)
- Grade II (pain on extreme of motion.)
- Grade III (pain on normal activity)
- Grade IV (pain at rest)

Range of motion: Compared with the normal wrist and expressed as percentage of normal motion.

Grip Strength: Measured with Novartis grip meter and expressed in percentage of normal side.

Statistical analysis

Data was processed and analyzed by unpaired t-test. Independent sample t-test for comparison of means. All statistical analysis was done using SPSS 11.5 program for Windows. P values less than 0.05 was taken as statistically significant.

RESULTS

Anatomical results

Our result revealed statistically significant difference in achieving the radial length. Other parameters though

better restored in operative group were not statistically significant (Table 1).

At six months follow up, restoration of dorsal angle, radial angle and radial length were significant. Other parameters were better in operative group but differences were not significant which revealed better restoration of distal radius anatomy in the operative group (Table 2).



Figure 3. AP X-ray comparing normal side wrist at 6 months follow up



Figure 4. X-ray AP and lateral view at 6 months follow up.

There was significant loss of dorsal angle, radial angle and radial length in conservative group after 6 months as compare to immediate reduction. (Table 3).

In operative group there was some collapse but difference was not significant indicating that in operative group reduction was better maintained. (Table 4)

Functional evaluation at six months follow up:

All parameters in functional evaluation were better in operative groups but none of them were statistically significant.

Two patients in conservative group developed reflex sympathetic dystrophy. Two patients in operative

group developed superficial marginal wound necrosis. No patient developed infection, bone graft donor site problem, compression neuropathy or tendon rupture.
 One patient developed non-union in operative groups.

Table 1. Anatomical evaluation immediately after close reduction.

	Conservative group (N=24)	Operative group (N=17)	P value
Dorsal angle (degrees)	-1.54	-4.11	0.335
Radial angle (degrees)	19.33	20.41	0.56
Dorsal displacement (mm)	2.16	1.17	0.22
Radial displacement (mm)	1.83	1.47	0.49
Radial length (mm)	7.33	10.05	0.001

Table 2. Anatomical results at 6 months follow up.

	Conservative group (N=19)	Operative group (N=16)	P value
Dorsal angle (degrees)	-2.68	-3.75	0.05
Radial angle (degrees)	15.94	19.56	0.006
Dorsal displacement (mm)	1.52	0.50	0.22
Radial displacement (mm)	2.68	1.87	0.15
Radial length (mm)	4.42	6.56	0.05

Table 3. Comparison of anatomical results after immediate reduction and after 6 months

Conservative group (N=16)	Immediate after reduction	At six months	P value
Dorsal angle (degrees)	-1.54	-2.68	0.033
Radial angle (degrees)	19.33	15.94	0.000
Dorsal displacement (mm)	2.16	1.52	0.855
Radial displacement (mm)	1.83	2.68	0.187
Radial length (mm)	7.33	4.42	0.000

Table 4. Comparison of anatomical results immediately after surgery and after 6 months.

Operative group (N=19)	Immediate after reduction	At six months	P value
Dorsal angle (degrees)	-4.11	-3.75	0.714
Radial angle (degrees)	20.41	19.56	0.001
Dorsal displacement (mm)	1.17	0.50	0.378
Radial displacement (mm)	1.47	1.87	0.382
Radial length (mm)	10.05	6.56	0.035

Table 5. Functional evaluation at six months follow up.

	Conservative group (N=19)	Operative group (N=16)	P value
Pain (Grade)	1.15	1.06	0.65
Dorsiflexion (%of normal)	74.89	78.06	0.57
Palmarflexion (%of normal)	85.31	91.50	0.18
Radial deviation (%of normal)	79.57	84.93	0.33
Ulnar deviation (%of normal)	87.00	87.81	0.92
Grid strength (%of normal)	81.05	85.50	0.38

DISCUSSION

Distal radius fractures are very common and expectations for recovery are usually high. Many reports testify to the good results to be expected from treatment of a Colles' fracture.⁶⁻⁸ Even Colles said that the injured limb would eventually regain "perfect freedom in all its motions."⁹ Optimism regarding the outcome of distal radial fractures has pervaded our thoughts regarding the Colles' fracture and deemphasized vigorous treatment.^{6,7,10} Certainly, many patients will do quite well with an imperfectly aligned Colles' fracture as has been pointed out many times, including the report by Lucas and Sachien in 1981.¹¹ However, some patients will have disabling symptoms from a healed malaligned fracture.^{7,8,11-13} Precisely how much malalignment can be tolerated by the wrist joint has not been determined, but certainly some imperfection is not incompatible with long-term satisfactory function.^{11,14-16} A study by Short et al demonstrates fairly conclusively, by pressure-sensitive film measurements, that loss of normal palmar tilt after simulated radial fracture leads to progressive load on the ulnocarpal and radioscaphoid joints.¹⁵ Loads become concentrated along the dorsal rim of the articulation, resulting in pain and ultimately joint degeneration.¹⁵ Their study demonstrates that at 40 degrees of dorsal tilt, the majority of load is carried by the distal ulna, which they believe contributes to pain and early degenerative joint disease development. Radial shortening has also been described as causing the greatest change in the distal radio-ulnar joint mechanics leading to distortion of the triangular fibrocartilage, joint stiffness and impairment of function with increased risk of permanent disability.^{14,17} Therefore, radial length should be restored as close as possible. The development of midcarpal instability following mal-united fractures of the distal radius has also been described.¹⁶ Obviously, the spectrum of problems with any sort of distal radial malunion is a continuum. Although anatomic alignment is not the only factor influencing the clinical result in a Colles' fracture, it is assumed that anatomic reduction will contribute greatly to improved results.

In our study we used tricortical bone graft to fill the dorsal comminution. The use of a block of cortico-cancellous bone block rather than small fragments of cancellous bone gives sufficient stability without the need for external fixation. Bone grafting is required for mechanical support rather than to stimulate healing. Early open reduction and bone grafting have the advantage over closed techniques of restoring the volar tilt. Ligamentotaxis has been shown to be an unreliable method of achieving this both in experimentally and in clinical practice.^{18,19} Restoration of palmar tilt may be significant in restoring normal function since loss of the normal palmar tilt may cause carpus to collapse dorsally.¹⁶

After close reduction or open reduction there was no statistical significant difference in anatomical parameters. This indicates that reduction is not a problem in majority of cases. Radial length is better restored in bone grafting groups as graft had given support to dorsal comminuted cortex. Our results of reduction is in accordance with McQueen et al who stated that in 95% cases close reduction is successful.²⁰ At six months follow up anatomical results were better in operative groups as there was significantly better restoration of dorsal angle and radial length. The functional outcome was not significantly different. We believe on the basis of our study that if mal-alignment is not significant short term functional outcomes are comparable. There are significant numbers of literature from the time of Abraham Colles to support this hypothesis.^{11,21,22} Our results contradict reports by McQueen et al and Villar et al where they showed direct correlation between anatomical reduction and range of motion and grip strength.^{23,24} Two patients who developed reflex sympathetic dystrophy in conservative group showed persistence of pain and reduced range of motion. In operative groups one patient developed non-union and gave poor result. The overall result shows operative group is better than conservative groups.

We encountered significant loss of reduction in terms of radial angle and radial length in both groups but dorsal angle was preserved in operative groups. This finding indicates that there will be some collapse even with this technique. Two patients who developed reflex sympathetic dystrophy in conservative groups were treated with physiotherapy. No case developed carpal tunnel syndrome or any case suggestive of carpal instability or ulno-carpal impingement was found. No case of tendon rupture was observed in our series as this is an uncommon complication which takes place after six to nine months of fracture. No infection was noticed in our series but there were only marginal skin necroses at the surgical margin in two early cases which were because of small skin incision and inadvertent retraction. In subsequent cases care was taken and no necrosis noticed.

Nonunion was found in one patient at six months. The cause we attribute retrospectively to comminution of volar cortex and graft was inserted in between. Literally there was no contact between proximal and distal fracture fragments. Union was solely dependent upon resorption and revascularisation of graft. The graft being tricortical in nature, cortical surface was facing towards fracture ends revascularisation was not possible. When we opened non-union site it was noticed that non-union was at the proximal fracture graft interface. Distal fracture was united with graft. Distal fragment was

volarily displaced. It was later fixed with volar buttress plate and screws. Fracture was protected for 10 weeks in below elbow cast. The non-union of distal radius fracture is rare. Usually it is because of over distraction by external fixators.²⁵

CONCLUSIONS

We conclude that reduction of Colles fracture can be done but maintaining in that position is problem. Open reduction and bone grafting is a useful method for the management of displaced Colles' fractures which prevents late collapse as compared to conventional casting. Functional results are comparable with the conventional cast application at least for the short term if significant malunion is avoided. Late complications of malunion as carpal instability and wrist arthrosis could not be assessed because of short term follow up. This procedure is invasive and adds bone donor site morbidity which can be considered as drawback.

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