Colles' Fracture : Analysis of Methods of Treatment and Factors Influencing Results

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ABSTRACT: A restrospective study of 263 patients with Colles' fracture treated at the Philippine General Hospital was done. Analysis of the various methods of treatment used and factors that would influence the choice of optimum treatment to achieve satisfactory results were identified.

The use of finger trap did not show superiority over grasped technique in reducing fractures. Maintenance of reduction is better provided by additional fixation devices (P = 0.0079) rather than the position of the wrist (P = 0.4062) and forearm (P = 0.4556). Circular cast showed better result than a splint (P = 0.0006). Long arm cast and short arm cast showed no difference in result of treatment (P = 0.1992) except that short arm cast has a higher rate of collapse (P = 0.0133).

Accurate articular restoration was the most critical factor in achieving satisfactory result (P = 0.0000). Articular and radial shaft comminution render the fracture unstable (P = 0.0000). The presence of residual articular incongruity greatly influence the developement of arthritis.

Colles' fracture (fracture of the distal radius with[1] dorsal angulation) is one of the most common and challenging fractures seen at the emergency room of the Department of Orthopedics at the Philippine General Hospital. As a result, various methods of treatment have been used with varying results.[2-5] In our hospital, there are as many methods of treatment as there are orthopedic residents. The lack of a standard method of treatment is not only seen in our institution but other centers as well.[4,6] Thus, there is a wide variation in results of treatment reported for this injury.[7-10]

Throughout the 170 years since Abraham Colles first described this fracture, various methods of treatment were forwarded and analyzed and factors influencing their end results were identified.[11,12] Still, there is no unanimity in its treatment.[2,13] This confusion exists because of the absence of clear indications that will guide the orthopedic surgeon in choosing an optimum treatment that would achieve the result that patients have come to demand.[14]

To achieve this, it is important that the decision in selecting the method of treatment must be tailored depending on the presence of fractors that are critical in influencing the result of treatment and the development of post-traumatic arthritis.

The purpose of this study are: 1. To analyze the various methods of treatment of Colles' fracture and their results in this hospital, 2. To determine the critical factors that would influence the choice of treatment for Colles' fracture in order to achieve satisfactory results.

MATERIALS AND METHODS

A retrospective review of patients with Colles' fracture treated at the emergency room and follow-up at the out-patient clinic of the Department of Orthopedics at the Philippine General Hospital from December, 1984 to February, 1987 was conducted.

Letters were sent to a total of 712 patients for reevaluation. Three hundred twelve (43.2%) of these patients responded. Because of a lack of pertinent data in some, only 263 (36.9%) of these patients were included in the study. The rest of the patients, 362 (50.8%) were lost to follow-up.

Out of the 263 patients, 135 (51.3%) were men and 128 (48.7%) were women. The average age of the patients was 42 years (range 18 to 79 years). The injury occurred on the dominant hand of 160 (61%) of the patients. The average duration of follow-up from the time of injury to evaluation was approximately 1 year (range: 6-26 months).

All Colles' fractures were treated by closed re-

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TABLE 1
Frykman's Classification of Colles' Fracture.

Fractures	Distal Ulnar Fracture Absent	Present
Extra-articular	I	II
Intra-articular involving radio-carpal joint	III	IV
Intra-articular involving radio-ulnar joint	V	VI
Intra-articular involving both radio-carpal and distal radio-ulnar joints	VII	VIII

duction and immobilized for 4-6 weeks depending upon evidence of clinical and radiological healing. One hundred fifteen (43.73%) fractures were reduced using the grasped technique while 140 (52.23%) fractures were reduced using the finger trap. The remaining 8 (3.04%) were immobilized without any attempt at reduction.

The position of the wrist and forearm during immobilization was varied. The wrist was either placed in neutral-neutral in 120 (45.60%) cases, neutral with flexion in 57 (21.7%) cases, flexion-ulnar deviation in 55 (20.9%) cases, and neutral with ulnar deviation in 31 (11.8%) cases. The forearm was positioned in neutral in 161 (61.2%) cases, pronation in 78 (29.7%) cases, and supination in 24 (9.1%) cases.

Two hundred twenty seven (86.31%) of the total fractures were immobilized in a plaster cast alone, 212 (93.4%) of which were circular and 15 (6.6%) were in a splint while 36 (13.69%) were immobilized with additional devices like pins in plaster cast or external fixature like Roger Anderson frame. Eighty one (30.8%) of the 227 wrists were immobilized in long arm cast while 182 (69.2%) in short arm cast.

The fractures were reduced under general anesthesia in 16 (6.1%) cases, 17 (6.5%) under regional block, 39 (14.8%) under hematoma block, 106 (40.3%) under sedation and 85 (32.3%) were reduced without any form of anesthesia.

The fractures were classified according to Frykman's system of classification (Table 1). Fifty five (20.91%) were type 1; 40 (15.21%) type 2; 53 (20.15%) type 3; 44 (16.73%) type 4; 26 (9.89%) type 5; 17 (6.46%) type 6; 20 (7.60%) type 7; and (3.04%) type 8.

The radiographic studies included x-ray of the injured wrist before and after reduction in antero-posterior and lateral views. The number of remanipulations done was noted, and the post-remanipulation x-ray was taken as the post-reduction x-ray. A final x-ray on the day of follow-up was taken for evaluation and comparison with the initial radiograph.

TABLE 2
Arthritis Grading.

Grade	Findings
0	None
1	Slight joint-space narrowing
2	Marked joint-space narrowing obsteophyte formation
3	Bone on bone, osteophyte formation, cyst formation

The initial radiographs were assessed to determine the amount of the initial deformity i.e. extent of dorsal and radial angulation[15] (Figure 1), the amount of ulnar displacement (ulnar styloid and ulnar shaft fracture), the amount of articular incongruity depending on the magnitude of the step-off (in millimeter)[16] of the articular surface of the distal part of the radius or disruption of the radio-ulnar joint and the presence of articular and radial shaft comminution of the distal radius. (Figure 2).

The follow-up examination included subjective, objective and radiographic evaluations. A detailed questionnaire was completed by each patient to evaluate subjective factors such as pain, functional limitations, appearance, disability and occupational considerations. Objective examinations included inspection of the wrist for deformity, palpation for tenderness or abnormal mobility of the distal radio-ulnar joint, measurements of the range of motion of the joints of the upper extremity, and evaluation of the light-touch and pin-prick sensibility. The contralateral limb was similarly evaluated and served as a control. Antero-posterior and lateral radiographs of both wrists were made and evidence of disruption of the distal radio-ulnar joint, residual articular incongruity and post-traumatic arthritis were recorded. The degree of arth-

ritis in the radio-carpal and radio-ulnar joint was graded from zero (normal) to 3 (extensive) using the system of arthritis grading by Knirk and Jupiter (Table 2).

The subjective, objective and radiographic findings were quantified using the demerit system of Gartland and Werley[15] (Table 3). The result of each treatment was graded as excellent, good, far and poor (Table 3). Statistical analysis of the data was performed using the Chi-square tests (p-value), Kruskall-Wallis One Way ANOVA, Fisher's exact probability test, and Independent t-test.

TABLE 3
Demerit Point System Used to Evaluate End Results of Healed Colles' Fractures.*

Results	Points
Residual Deformity	
Prominent ulnar styloid	1
Residual dorsal tilt	2
Radial deviation of hand	2 – 3
Point Range	0 – 3
Subjective evaluation	
Excellent-no pain, disability, or LOM	0
Good-occ. pain, slight LOM, no disabil.	2
Fair-occ. pain, slight LOM, weakness in wrist	4
Poor-pain, LOM, disability, activity restricted	6
Point Range	0 – 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 cicumduction	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 – 3
Poor finger function due to cast	1 – 2
Point Range	0 – 5
End-resutl Point Ranges	
Excellent	0 – 2
Good	3 – 8
Poor	9 – 20
Fair	21 and above

*From Evaluation of healed Colles' fractures. JJ. Garland and CW. Werley. JBJS, 33A:900, Oct. 1951.

+Minimum for normal function: dorsiflexion: 45 degrees, palmar flexion 30, radial deviation 15, ulnar deviation 15, pronation 50, and supination 50 degrees.

RESULTS

The different methods of treatment of Colles' fracture presently used in this institution were analyzed with emphasis on the early result of treatment and the rate of collapse or remanipulation (Tables 4 and 5).

The method of reduction used was either performed by applying traction through the grasped injured hand or by distraction using Chinese finger traps before reducing the fractured fragments into position. This study showed that the method of reduction does not affect the result of treatment (P = 0.7975). The rate of remanipulation is likewise not affected by the method of reduction (P = 0.2206). To determine whether the use of finger trap or grasped technique affects the amount of correction achieved, Kruskall-Wallis One Way ANOVA was employed. Neither method of reduction was superior over the other in terms of the amount of correction achieved (Table 6).

After applying traction on the fracture fragments, the wrist is positioned inside a cast in such a way that reduction of the fracture is achieved. The position of the wrist varies depending on the fracture configuration. In this study, several positions were identified and results showed that the position of the wrist during immobilization inside a cast does not affect the result of treatment (P = 0.4062). The rate of collapse is likewise not affected by the position of the wrist inside the cast (P = 0.4693).

Positioning of the forearm inside a cast is likewise varied. In this study, the position of the forearm was noted to significantly affect (P = 0.0004) the outcome of treatment. Cases immobi-

TABLE 4
Results of the Chi-Square Tests Comparing Effects of Various Methods of Management on Early Result.

Management	Result (%) Excellent	Good	Fair/Poor	P-value
1. Method of reduction				
Grasped	15.65	55.65	28.70	0.7975
Finger trap	17.14	51.43	31.43	
2. Type of cast				
Circular	16.94	54.84	28.22	0.0006*
Splint	20.00	6.67	73.33	
3. Method of immobil.				
Cast	29.07	40.97	29.96	0.7422**
Pins/Ext. fixature	25.00	38.89	36.11	
4. Length of cast				
LAC	22.22	53.09	24.69	0.1992
SAC	14.84	51.64	33.52	
5. Wrist position				
Neutral-flexion	22.81	45.61	31.58	0.4062
Neutral-ulnar dev.	16.13	61.29	22.58	
Neutral-neutral	13.33	50.83	35.83	
Flexion-ulnar dev.	20.00	56.36	23.64	
6. Forearm position				
Pronation	20.51	42.31	37.18	0.0004
Supination	0	37.50	62.50	
Neutral	18.01	59.01	22.98	
7. Type of anesthesia:	not significant due to small subjects in some cells			

*Excellent and good categories were combined and Fisher's Exact-P was used.

**Chi-square test was done by combining excellent and good categories of final result.

TABLE 5
Results of the Chi-Square Tests Comparing Effects of Various Methods on Number of Remanipulation.

Management	Rate of Remanipulation 0	Rate of Remanipulation >1	P-value
1. Method of reduction			
Grasped	55.07	44.93	0.2206
Finger trap	77.78	22.22	
2. Type of cast			
Circular	64.52	35.48	0.6770
Splint	73.33	26.67	
3. Method of immobilization			
Cast	58.89	41.41	0.0079
Pins/ext. fixature	83.33	16.17	
4. Length of cast			
LAC	76.54	23.46	0.0133
SAC	59.89	40.11	
5. Wrist position			
Neutral-flexion	68.42	31.58	0.4693
Neutral-ulnar deviation	51.61	48.39	
Neutral-neutral	66.67	33.33	
Flexion-ulnar deviation	65.45	34.55	
6. Forearm position			
Pronation	64.10	35.90	0.4556
Supination	54.17	45.83	
Neutral	67.08	32.92	
7. Type of anesthesia			
GA	56.25	43.75	0.1916
Regional block	47.06	52.94	
Hematoma block	56.41	43.59	
Sedation	66.98	33.02	
None	71.76	28.24	

TABLE 6
Results of the Kruskall-Wallis One Way ANOVA Comparing Effects of Different Methods of Closed Reduction on Amount of Reduction Achieved.

Measure of Reduction Achieved	Grasped X ± sd	Finger Trap X ± sd	None X ± sd	P-value
Dorsal angulation	2.84 ± 5.53	2.69 ± 5.91	4.25 ± 5.15	0.2551
Radial angulation	16.66 ± 7.90	17.11 ± 6.35	13.12 ± 9.61	0.6335
Ulnar displacement	7.87 ± 17.92	6.84 ± 17.28	3.12 ± 8.84	0.5017
Artic. incongruity	0.75 ± 1.14	0.91 ± 1.17	2.00 ± 2.00	0.121 4

lized in pronation and neutral position showed 62.82% and 77.02% good to excellent result respectively while only 37.5% good to excellent result on those immobilized in supination. The position of the forearm does not control the rate of collapsed significantly (P = 0.4556).

A total of 93.4% of the wrists were immobilized in a circular cast while 6.6% were immobilized in a splint. This study showed that cases immobilized in a circular cast have a significantly better result than those immobilized in a splint (P = 0.0006). However, circular cast does not show any significant advantage (P = 0.6770) over the splint in terms of controlling the rate of collapse or remanipulation.

Immobilization of the injured extremity was done either with a cast that extend above or below the elbow. In this study, 30.8% of cases were immobilized in long arm cast while 69.2% were immobilized in short arm cast. Analysis have shown that there is no statistically significant difference between the two with regards to its effect on the result of treatment (P = 0.1992). However, there is significantly higher rate of collapse or remanipulation in short arm cast than long arm cast (P = 0.0133).

Although an additional fixation device offers the advantage of maintaining the reduction while allowing the fingers to remain functional, this study showed that there is no significant effect (P = 0.7422) on the result whether the fracture was immobilized by a cast alone or with additional fixation devices like pins or external fixature. However, the rate of collapse is significantly less in cases where pins or external fixature was used (P = 0.0079).

The use of anesthesia would provide adequate muscle relaxation and allow the surgeon to be more exact in reducing the fracture. Analysis was made whether the type of anesthesia used would affect the result of treatment and the rate of remanipulation. This study showed that the type of anesthesia does not influence the result of treatment and the rate of remanipulation (P = 0.1916). To determine whether the type of anesthesia used affects the amount of reduction achieved, the Kruskall-Wallis one way ANOVA was employed and showed that the type of anesthesia used significantly affects the amount of reduction achieved (1 = .05) with general anesthesia achieving the highest reduction (Table 7).

Based on the above result, it is obvious that the treatment of Colles' fracture is influenced by the presence of other factors (Table 8).

TABLE 7
Results of the Kruskall-Wallis One Way ANOVA Comparing Effects of Different Types of Anesthesia on Amount of Reduction Achieved.

	Anesthesia					
	GA	Regional	Hematoma	Sedation	None	P°value
	X ± sd	X ± sd	X ± sd	X ± sd	X ± sd	
1)	2.63 ± 3.54	2.29 ± 3.27	2.85 ± 6.05	1.74 ± 3.55	4.25 ± 7.85	0.0360
2)	16.06 ± 7.10	15.06 ± 6.30	18.44 ± 8.70	17.59 ± 6.07	15.54 ± 7.7	0.2796
3)	18.9 ± 38.17	14.7 ± 18.75	4.31 ± 8.60	4.49 ± 12.27	8.12 ± 18.4	0.0337
4)	1.69 ± 1.40	1.71 ± 1.16	1.0 ± 1.15	0.54 ± 0.82	0.92 ± 1.42	0.0001

*measure of reduction achieved: 1) dorsal angulation 2) radial angulation 3) ulnar displacement 4) articular incongruity

TABLE 8
Results of One Way ANOVA Comparing the Effects of Various Fracture Components on Final Result.

Fracture Components	Mean	F-value	P
Dorsal angulation	38.11	0.53	0.5882
Radial angulation	159.07	2.82	0.0612
Ulnar displacement	1,626.45	1.66	0.1921
Articular incongruity	66.16	35.75	0.0000

Dorsal Angulation

In the normal wrist, the lower end of the radius has a distinct concavity and the articular surface is directed slightly forward as well as downward. This is called the volar tilt[13] (Figure 1). After a Colles' fracture, the distal radial fragment is displaced and tilted backward and dorsally. This is called the dorsal angulation, measured in degrees (Figure 2).

Analysis of the distal radial fragment that healed in a position with residual dorsal angulation (range of 0-21 degrees and mean of 11.71 degrees) showed that this angulation does not affect the result of treatment (P = 0.5882).

Radial Angulation

The second component of a Colles' fracture is loss of the normal radial length or radial angulation. Normally, it has an angle of 13-30 degrees, with an average of 23 degrees. After a Colles' fracture, the angle is decreased and in this study, it was as low as 0 degrees. The result of this study showed that residual radial angulation likewise does not affect the result of treatment (P = 0.0612).

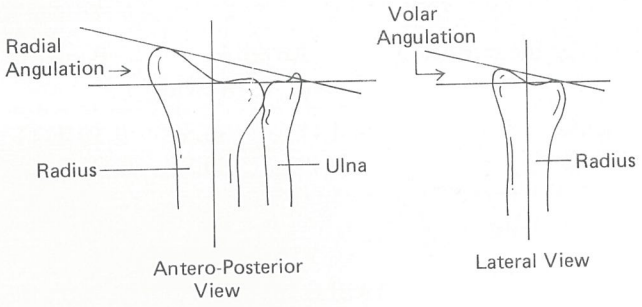

Fig. 1 Radial and volar angulation of the normal distal radius

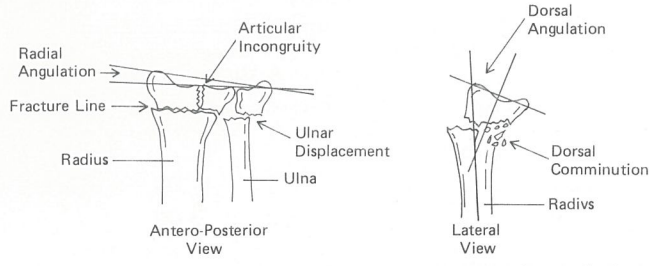

Fig. 2 Determination of the radial and dorsal angulation in Colles' fracture.

Ulnar Displacement

A total of 109 (41.44%) cases had an associated ulnar fracture. An analysis was done to determine whether the presence of concommitant ulnar shaft displacement would affect the result of treatment. The displacement of healed ulnar shaft fracture ranged from 0 to 100% (mean:21.97%). This study showed that the presence of a residual ulnar displacement does not affect the result of treatment (P = 0.1921).

Articular Incongruity

The presence of articular incongruity was noted to be the most critical factor in achieving a successful result. This study showed that the presence of articular incongruity would greatly affect the result of treatment (P = 0.0000).

There were 120 cases with articular incongruity with a step-off of 1 mm. to 6 mm. (mean of 1.59 mm.). Of these, 67 (58.83%) cases have fair to poor result while 53 (44.17%) have excellent to good result. Those without articular incongruity have 90.21% good to excellent result while only 9.79% have fair to poor result. This difference is statistically significant (P = 7.594E-11) as shown in Table 9

Presence of Comminution

An analysis was made to determine whether the presence of articular and radial shaft comminution would affect the result of treatment. This study showed that more patients with articular comminution end up with fair or poor result than those who do not have. The same trend can be observed for patients with radial shaft comminution (Table 10). This is highly significant at P =

TABLE 9
Results of Chi-Square Test Investigating the Effect of Articular Incongruity on Final Result.

Articular Incongruity	Results		P-value
	Excellent/Good	Fair/Good	
Presence	44.17	58.83	7.594E-11
Absence	90.21	9.79	

TABLE 10
Result of the Chi-Square Tests Investigating the Relationship of Presence of Absence of Articular and Dorsal Comminution on Final Result.

	Results			
	Excellent	Good	Fair/Poor	P-value
Articular comminution				
Present	6.25	43.75	50.00	0.00002
Absent	20.60	54.78	24.62	
Dorsal Comminution				
Present	7.78	47.78	44.44	0.0004
Absent	21.97	54.34	23.69	

TABLE 11
Results of the Chi-Square Tests Investigating the Relationship of Presence or Absence of Dorsal comminution on Rate of Remanipulation.

Dorsal Comminution	Rate of Remanipulation		P-value
	0	½ 1	
Present	42.22	57.78	0.0000
Absent	76.88	23.12	

TABLE 12
Results of the Chi-Square Tests Investigating the Effect of Presence or Absence of Articular Incongruity on the Development of Arthritis.

Articular Incongruity	Arthritis		P-value
	Present	Absent	
Presence	64.17	35.83	7.594E-11
Absence	10.49	89.51	

0.000002 and 0.0004 respectively.

An analysis was made to determine whether the presence of dorsal or radial shaft comminution would affect the rate of collapse. This study showed that the presence of radial shaft comminution significantly (0.0000) increases the rate of remanipulation (Table 11).

Development of Arthritis

The development of arthritis was shown to be dependent upon the ability in maintaining or achieving a congrous joint. This study showed that cases with incongrous joint have higher rate of arthritis (64.17%) than those without articular incongruity (10.49%). This was noted to be highly significant at P = 7.594 E-11 as shown in Table 12.

The presence of articular comminution would predispose to the development of arthritis (P = 5.274-06). This is also true with dorsal or radial shaft comminution (P = .0289) as shown in Table 13.

TABLE 13
Results of the Chi-Square Tests Investigating the Relationship of Presence or Absence of Articular and Dorsal Comminution on the Development of Arthritis.

	Arthritis		P-value
	Present	Absent	
Articular Comminution			
Present	59.00	41.00	0.000005
Absent	27.00	73.00	
Dorsal Comminution			
Present	44.00	56.00	0.0289
Absent	30.00	70.00	

Although residual articular incongruity frequently resulted in post-traumatic arthritis, the development of arthritis is dependent upon the degree of step-off in the joint surface.[16] In this study (Table 14), the mean residual articular incongruity (1 millimeter) was noted to be slightly higher among those who did not develop arthritis than those who later developed arthritis. However this is not statistically significant (P = 0.5371). The presence of residual ulnar shaft displacement did not appear to contribute to the development of arthritis.

TABLE 14
Results of the Independent t-Test Comparing Patints Who Developed Arthritis with Those Who Did Not.

	Arthritis		P-value
	With Arthritis X ± sd	Without Arthritis X ± sd	
Residual Articular Incongruity	0.66 ± 1.04	0.75 ± 1.08	0.5371
Residual Ulnar Shaft Displacement	14.17 ± 25.43	15.13 ± 25.59	0.7727

TABLE 15
Results of Chi-Square Tests Comparing the Effects of Different Types of Colles' Fracture According to Frykman's Classification on Final Results.

Frykman Classification	Results		
	Excellent[6]Good	Fair[6]Poor	Total
I	92.73	7.27	20.91
II	87.50	12.50	15.21
III	67.92	32.08	20.15
IV	77.27	22.73	16.73
V	46.15	53.85	9.89
VI	35.29	64.71	6.46
VII	30.00	70.00	7.60
VIII	25.00	75.00	3.04
Total	69.20	30.80	100
	X = 59.36	P-value = 0.0000005	

Type of Fracture

When the type of fracture incurred is analyzed in relation to the result, this study showed that the more complex the fracture, the poorer the result. Intra-articular fractures have poorer results than those without radio-carpal joint involvement. The presence of both joint involvement would have the poorest result. A concommitant ulnar fracture has a negative effect on the result of treatment as well (Table 15).

Complications

It is known that the presence of complications can delay the early return of function of the hand.[6,32] These are injury to the nerve and tendons. In this study, no incidence of tendon rupture was noted. There were two cases who had symptoms referable to median nerve compression. The patients, however, did not fell it was severe enough to warrant operation.

DISCUSSION

There have been many methods recommended for the treatment of Colles' fracture.[4,9,14,17-20] In this hospital, the treatment of Colles' fracture is varied and it seems apparent that there are no specific guidelines being followed. The results of the study have shown, however, that there are certain practices that have specific advantages over the others.

Majority of Colles' fractures in this study were managed conservatively with closed reduction and plaster of Paris cast or splint. The method of closed reduction is done depending upon the preference of the surgeon. While others recommend the use of grasped technique[21-23] in order to fully

manipulate the fracture fragments,. some would favor a Chinese finger trap[14,17,23] in order to allow adequate traction while freeing the hand during manipulation. Both methods are acceptable and no apparent advantage was noted with regards to influencing the result and the amount of correction obtained.

After disimpacting the fracture fragments, the distal radius is reduced in a position where stability and anatomical configuration is restored. This is done by placing the wrist and the forearm into a desired position. Some authors would advocate placing the wrist in flexion and ulnar deviation[3,18,24] or neutral position with mild flexion[4,6,15] to achieve stability of reduction. Forearm position is likewise complicated with others favoring pronation[1,5,10,25] while others advocating supination[5,26-28] in order to eliminate the effect of deforming muscles. However, there is no clear indications when to use pronation or supination in such fracture.[5] This study showed that the position of the wrist and the forearm do not control the rate of collapse of the fracture fragments ($P = 0.4693$ and $P = 0.4556$ respectively). This means the position of the wrist and the forearm is related more to achieving the anatomical reduction rather than relaying on these positions in maintaining the stability of reduction. This is in contrast to what other authors believe that the position of the wrist and forearm would lock[1,25-27,29] the fracture into position, which probably applies only in simple Colles' fracture where is it already stable in the first place.

The use of dorsal and volar splint in this study were limited to untreated cases seen several weeks after injury or among those severely comminuted fractures where reduction was not performed. This explains why the result of cases treated with circular cast showed satisfactory result than those treated with a splint. Although there is no difference between the two methods in terms of controlling the rate of collapse, those treated with a splint did not have remanipulation since the deformity was already accepted at the outset. While others would still recommend the use of a splint,[24] this is more advisable in simple Colles' fracture where articular involvement is not present. Circular cast is indicated in more complicated fracture which would require a more adequate form of immobilization.[5,16]

Studies have shown that anatomical and functional results are the same with the use of long arm cast and short arm cast.[2,11] Therefore, majority would favor the use of short arm cast since functional improvement is better and quicker.[4,11,30] This study showed that in choosing between short arm cast and long arm cast, the decision must be based on whether the configuration of the fracture is stable or unstable. Although the end results are the same, short arm cast has a higher rate of collapse than long arm cast ($P = 0.0133$). It is therefore important that the fracture pattern must be determined in order to assess the stability of the fracture. If the fracture was noted to be unstable, the use of long arm cast is advisable.

Studies by Lacroix[19] and Vaughan[31] have shown that fractures with dorsal cortex comminution, presence of articular comminution,[14,16,32] presence of dorso-medial fragment or diepunch fracture[33] and severe radial shortening (> 10 mm)[32] and dorsal tilt (> 25 degrees),[19] although not intra-articular, constitute unstable fractures and would predispose to collapse. These unstable fractures demand a more vigorous approach to achieved satisfactory results. As was reported by various authors,[20,31,34] this study showed that the use of external fixature, percutaneous pins, and pins and plaster have significantly prevented collapse ($P = 0.0079$) and provided stability to the fractured fragments.

Although the type of anesthesia has nothing to do with fracture pattern and stability, satifactory reduction is achieved better with adequate form of anesthesia. In a severely displaced fracture, difficult reduction should be anticipated and the use of general or regional anesthesia is favored.

Thus far, the evidence fromthis study indicates that the decision in treating Colles' fracture is dependent to a great extent on the inherent quality of the fracture itself that would influence the result of Colles' fracture treatment. Most authors believe that in order to consistently achieve excellent results, the reduction must correct all the elements in the deformity of Colles' fracture.[13,24,35] Furthermore, various studies have shown that anatomical restoration of dorsal and radial angulation and concommitant ulnar displacement would mean satisfactory functional restoration.[3,14,16,17] This study showed that these factors mentioned did not prove to be as critical in the determination of the result of treatment. Residual dorsal and radial angulation and ulnar displacement did not prove to influence the result of treatment. While others may disagree, it should be pointed out that the mean residual deformity noted in this study were lower than those noted by Lacroix and Vaughan.

The presence of articular incongruity was shown to be the most critical factor that would in-

fluence the result of treatment and the development of arthritis. In the treatment of Colles' fracture with articular incongruity, effort must be done in order to accurately restore the articular surface since success of recovery parallels the accuracy of reduction.[4,14,17] This can be done with the use of additional fixation like percutaneous K-wires as recommended by Dowling and Clancy,[22,17] pins and plaster or external fixature,[20,31,34] which would improve both the anatomical and the functional results. Restoration should not only be limited to the radio-carpal joint but must also include the radio-ulnar joint which contributes greater functional handicap to the patients.[16,36]

The presence of articular and dorsal comminution should alert the surgeon of the high incidence of collapse and the difficulty in reducing it. As noted by Vaughan and Melone, the presence of more than 2 fragments would predispose to collapse. Thus, treatment must be geared towards prevention of such. This can be done with the use of additional fixation devices. In cases were articular comminution and severe loss of the dorsal cortex are present, open reduction and bone grafting may be indicated.[14,19,32]

Arthritis developed in cases were articular surface was not restored. In this study, the absence of arthritis is dependent upon obtaining a congrous joint. Studies have shown that joint surface with residual incongruity of 2 millimeters or more would significantly predispose to the development of arthritis.[16] This was not seen in this study since the mean residual incongruity of all cases was only 1 millimetter. However, this must serve as a guide as to the limit of acceptable incongruity.

The classification used in this study was based on the system advocated by Frykman.[37] Although this would predict the outcome of treatment and possibility of collapse, information regarding treatment and prognosis were not seen. The degree of comminution which would predict instability were likewise not included in this classification. In the choice of an optimum treatment for Colles' fracture, congruency of the articular surface, comminution of the joint surface and the distal radial shaft should be included in the decision making process.

CONCLUSION AND RECOMMENDATION

The methods of management of Colles' fracture in this hospital are varied although certain practices have specific advantages over the others.

Manipulation of the fracture fragments can be done either with the use of grasped technique or finger trap. Neither of the two have superiority over the other.

The stability of reduction cannot be relied upon the position of the wrist and the forearm inside the cast. Stability of reduction is dependent more on other factors like the type of cast or additional fixation devices. Positioning of the wrist and the forearm is related more in achieving anatomical reduction rather than stability of reduction.

The use of a short arm cast is preferable over a long arm cast since it is cheaper, easier to apply, with quicker return of function and still attainning the same result. Limitation of its use, however, must be recognized.

The use of additional fixation devices like pins and external fixature is indicated if the fracture pattern is unstable. Thus, there is a need to understand the meaning of unstable fractures.

Adequate anesthesia is needed in order to achieve better reduction.

Residual dorsal angulation, radial angulation and ulnar displacement do not appear to influence the result of treatment.

Accurate articular restoration was the most critical factor in achieving a successful result and prevention of arthritis.

Articular and radial shaft comminution should alert the surgeon of the high incidence of collapse associated with their presence.

All these factors must be included in deciding an optimum treatment for Colles' fracture.

As a result of this study, Colles' fracture may be approached in the following manner: An initial attempt at closed reduction, incorporating both longitudinal traction with the use of finger trap and manipulative reduction by grasped technique, and accomplished under appropriate anesthesia. The wrist and the forearm is positioned in a manner where anatomical reduction is achieved. Once anatomical or acceptable reduction is achieved, short arm cast immobilization is applied. Factors like presence of articular and radial shaft comminution must guide the surgeon in selecting the appropriate form of immobilization. Additional fixation devices like pins and plaster or external fixature are indicated if the fracture pattern is unstable as defined in this study. If the surface of the joint remains impacted with more than 2 millimeter incongruity after reduction, additional fixation devices like percutaneous pins should be considered. If still inadequate, the possibility of open reduction and internal fixation plus bone grafting may be considered.

ACKNOWLEDGEMENT

The author thanks Cynthia Cordero, Biostatistician, Clinical Epidemiology Unit, Department of Medicine, UP PGH Medical Center, for her assistance in the statistical analysis of the data.

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