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Surgical Management of Galeazzi Fractures - A Clinical Study of 42 Patients

K P Riju

Assistant Professor, Department of Orthopedics, KMCT Medical College, Mukkom, Manassery, Calicut, Kerala, India

Abstract

Introduction: Fracture of the lower end of radius and Galeazzi fractures are common in orthopedic practice all over the world. The distal radioulnar joint disruption usually is simple in nature, which gets reduced spontaneously after radius fixation. Sometimes, this can be complex which can be irreducible because of the entrapped bone or tendon - most often extensor carpi ulnaris tendon. There are different methods of approaches and modes of internal fixation described in the literature. The present study is to analyze the results post-operatively following internal fixation with plate and screws.

Materials and Methods: A total of 42 patients with distal radial fracture and Galeazzi fractures were randomly selected and subjected to internal fixation with dynamic plate and screws. Post-operatively, the results were analyzed using Mayo wrist score and piano tests.

Results: There were 28 (64.28%) male patients and 15 (35.71%) female patients. Age of the patients ranged between 22 years and 60 years with a mean age of 43.7 years. Grip strength was excellent in the majority of the patients with stable distal radioulnar joint. Statistical analysis shows a significant correlation between grip strength and distal radioulnar joint stability ($P < 0.05$). There was a significant correlation between deficits in the range of pronation/supination with age groups in the present study. Four patients in the age group of above 50 years had pronation supination difference of 30-50.

Conclusion: The treatment of the Galeazzi fractures is anatomic restoration of length of the radius with application of rigid internal fixation to maintain the reduction.

Key words: Functional outcome, Galeazzi fracture, Internal Fixation, Radioulnar joint, Piano test

INTRODUCTION

Fractures of the distal end of the radius are one of the most common skeletal injuries treated by the orthopedic surgeons, the world over. By definition, Galeazzi fracture involves fracture of the shaft of radius anywhere between radial tuberosity and a point 2-4 cm proximal to the wrist, associated with subluxation or dislocation of the lower end of the ulna. It was first reported in 1822 by Sir Astley Cooper, and nearly, 110 years later by Riccardo Galeazzi of Milan.[1,2] Most often, the fractures occur at the junction of middle 1/3 and distal 1/3 between the insertion of pronator teres and pronator quadratus.[3] Whether the mechanism of injury is direct or indirect, the radial fracture occurs first followed by disruption of distal radioulnar joint. The distal radioulnar joint disruption usually is simple in nature, which gets reduced spontaneously after radius fixation.[4] Sometimes, this can be complex which can be irreducible because of the entrapped bone or tendon - most often, extensor carpi ulnaris tendon. In 1941, it was termed by Campbell as the fracture "the fracture of necessity"[5] necessitating surgical treatment since non-surgical treatment in adults results in persistent or recurrent dislocations of the distal ulna. In 1957, Houghston[3] outlined the definitive management of these fractures. Early treatment of choice is open anatomical reduction with rigid secure internal fixations. Resection of the distal portion of the ulna and bone grafting should be seriously considered in fractures brought after 3-4 weeks. Restoration of good function in fractures treated late appears to be most successfully accomplished by means of intramedullary fixation combined with bone grafting of the radius and resection of distal portion of ulna. In 1975, Mikic[4] in his study involving 125 patients, he concluded that conservative management is successful only in children. In adults, this method

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Corresponding Author: Dr. K P Riju, Department of Orthopedics, KMCT Medical College, Mukkom, Manassery, Calicut, Kerala, India.
E-mail: rijukp1@gmail.com

resulted in failure in 80% of cases. The fracture fragments of radius and the dislocation of the distal radioulnar joint in this complex injury are very unstable. He advised open reduction and internal fixation of radius and temporarily fixes the distal radioulnar joint with 1 or 2 Kirschner wires. In 1982, Reckling[5] in his study involving 47 Galeazzi lesions concluded that neither of the procedure described before immediate resection of distal part of the ulna and temporary fixation of distal radioulnar joint with Kirschner wires was necessary. Uniformly, good results have been obtained by open anatomical reduction, internal fixation of the radial fixation, and immobilization of forearm in full supination. In 1985, Moore *et al.*[6] observed that compression plating was a satisfactory method of management. In 1988, Mohan *et al.*,[7] in his study of 50 patients, observed that early open reduction and internal fixation reestablish the normal relationship of the fractured fragments and the distal radioulnar joint without repair. In 1993, Strehle and Gerber[8] in their study concluded that open revision, repair of triangular of bio-cartilage complex, and immobilization of the wrist are not necessary if anatomic reduction of the joint is obtained by indirect means of open reduction and internal fixation of the radius. In 1994, Beneyto *et al.*,[9] in their study, concluded that anatomical reduction and internal fixation of the fracture are better than conservative management. Immobilization in a fully supinated position is recommended to reduce the dislocation of distal radioulnar joint. Additional temporary fixation of distal radioulnar joint is also necessary in case of severe derangement of the joint. In 2001, Rettig and Reskin[10] introduced a new treatment-oriented classification and concluded that a high index of suspicion, early recognition, and acute treatment of distal radioulnar joint instability will avoid chronic problem in this complex injury. In 2005, Ring *et al.*[11] concluded that isolated radial shaft fractures are more common that Galeazzi fractures. The present study was conducted to review the post-operative functional results using different methods of surgical approaches and techniques in our hospital.

Aim of the Study

This is aimed to study the distal radial fractures in terms of its type, mechanism of injury, results of surgical treatment, and its complications, to analyze the efficacy of surgical techniques in achieving reduction and restoring the congruency of joint and stability of distal radioulnar joint, and to assess the functional outcome of distal radioulnar joint in Galeazzi fractures treated by surgical method.

Study Period

The study period is from July 2011 to June 2013.

Institute of Study

KMCT Medical College Hospital, Mukkom, Manassery, Calicut, Kerala, India, was selected for the study.

MATERIALS AND METHODS

The present study is a hospital-based prospective study evaluating the results of surgical management of Galeazzi fracture dislocation in a series of 42 cases. Patients attending the Department of Orthopedic and Trauma Unit of the KMCT Hospital were included in the study. Ethical committee clearance was obtained, and a consent form approved by the ethical committee was used during the study.

Inclusion Criteria

1. Patients with fracture shaft of radius with an associated dislocation of distal radioulnar joint were included.
2. Patients with fracture of shaft between bicipital tuberosity proximally and an area 4-5 cm from the distal articulating surface of radius distally were included.
3. Patients with the Galeazzi fracture-dislocation above the age of 15 years were included.
4. Patients with Galeazzi fracture-dislocation associated with neurovascular injury were included.
5. Patients with compound fracture type 1 (Gustillo Anderson classification) were included in the study.

Exclusion Criteria

Patients with following criteria were excluded from the study:

1. Galeazzi fracture-dislocation <15 years.
2. Fracture of distal end of radius (e.g., Colle's fracture).
3. Fracture of radial head and neck.
4. Associated with fracture of ulna.
5. Associated with posterior dislocation of the elbow.
6. Old malunited fracture of radius.
7. Pathological fracture.
8. Compound fracture Type 2 and 3 (Gustilo-Anderson classification).

Management

All patients on presentation to the emergency department were initially immobilized in above elbow Plaster of Paris slab. After the general condition of the patient was stabilized, detailed history was taken to determine the mechanism of trauma, and clinical evaluation was done to determine the status of soft tissue envelope, fracture pattern, and associated fractures and neurovascular competence. Plain radiographs were taken in anteroposterior and lateral views. Pre-operative surgical profile was done before taking up for surgical correction.

Surgical Procedures

All the surgeries were performed under general anesthesia (28) or brachial block (14). Tourniquet was used in all cases. Surgical approaches used were volar (37 cases) and dorsal (5 cases). The fracture is reduced with the help of reduction forceps and traction. A 3.5 mm narrow dynamic compression plate (NDCP) was used in all patients to immobilize the fracture. The surgical steps and criteria used were:

- Fracture and distal radioulnar joint was evaluated for reduction.
- No K-wire was used to fix the distal radioulnar joint.
- Distal radioulnar joint exploration was not done in any case.
- No primary bone graft was used.
- Tourniquet released, hemostasis attained before closure.
- Wound closed in layers.
- Above elbow, slab is applied to all cases with the forearm in supination.
- Upper extremity was elevated for 1-day post-operative.
- Check X-ray was done for every case to assess the reduction of fracture and distal radioulnar joint.
- Neurological and vascular status was aroused.
- IV antibiotics were given for all patients for 7 days.
- Sutures were removed by 10th day.
- Splint was replaced with above elbow cast in supination.

Follow-up

Patients were followed up at an interval of 6 weeks for 6 months. At 4-6 weeks, the cast is removed. Radiograph obtained, and physiotherapy was initiated for the elbow and wrist motion. The "Piano Keys" test and the supination lift test are used to assess the distal radioulnar joint stability apart from radiological diastases.

Mayo Wrist Score

The Mayo wrist score was used to evaluate the wrist function on the basis of pain, satisfaction, range of motion, and grip strength. Grip strength of the injured and contralateral hands was measured using a hand dynamometer. The wrist score is reported as the percentage of that obtained in the normal site.

Mayo Wrist Scoring System

Category	Score	Findings
Pain (25 points)	25	No pain
	20	Mild pain with vigorous activities
	20	Pain only with weather changes
	15	Moderate pain with vigorous activities
	10	Mild pain with activities of daily living
	5	Moderate pain with activities of daily living
	0	Pain at rest
Satisfaction (25 points)	25	Very satisfied
	20	Moderately satisfied
	10	Not satisfied, but working
	0	Not satisfied, unable to work
Range of motion (25 points)	25	100% of normal
	15	75-99% of normal
	10	50-74% of normal
	5	25-49% of normal
	0	0-24% of normal
Grip strength (25 points)	25	100% of normal
	15	75-99% of normal
	10	50-74% of normal
	5	25-49% of normal
	0	0-24% of normal
Final result (total points)	90-100	Excellent
	80-89	Good
	65-79	Fair
	< 65	Poor

The results are classified as excellent, fair, and poor. An excellent result is one in which there is: (a) Union, (b) perfect alignment, (c) no loss of length, (d) no subluxation of the distal radioulnar joint, (e) no limitation of supination or pronation, and (f) no limitation of wrist flexion-extension. A fair result is one in which there is: (a) Delayed union, (b) minimal misalignment (5-10°), (c) minimal SHORTENING (0-4 mm), (d) subluxation/unstable, (e) limitation of pronation supination <45°, (e) excessive scar, and (f) loss of grip strength - 30-50%. A poor result is one in which there is: (a) Non-union, (b) angulation >10°° (c), loss of length > 5 mm, (d) dislocation of distal radioulnar joint, (e) limitation of pronation and supination >45°, (f) wrist flexion-extension limitation >45°, (g) pain, and (h) grip strength loss >15%.

Criteria for Classification of Results

Criteria	Excellent	Fair (one or more)	Poor (one or more)
Union	Solid	Delayed union	Nonunion
Alignment	Perfect 0-5°	Minimal malalignment 5-10°	>10° angle
Loss of length	Nil	Minimal shortening 0-4 mm	Marked shortening ≥5 mm
Distal radioulnar joint	Stable	Subluxation/ Unstable	Dislocation
Supination and pronation	Full	Limitation <45°	Limitation >45°
Wrist flexion and extension	Full	Limitation <45°	Limitation >45°
Pain	Nil	Excessive scar	Pain
Grip strength	<30%	30-50%	>50%

All the data were analyzed using standard statistical methods. The following statistical methods were applied in the study.

1. Crosstabs procedures (contingency coefficient test).
2. Chi-square test.
3. Descriptive statistics.
4. One-way ANOVA.
5. Independent sample *t*-test.

OBSERVATIONS AND RESULTS

A total of 42 patients were included in the present study among the patients attending the department of orthopedics of KMCT Medical College Hospital between

July 2011 and June 2013. There were 28 (64.28%) male patients and 15 (35.71%) female patients. Age of the patients ranged between 22 years and 60 years with a mean age of 43.7 years. The distribution of number of patients according to their age groups is depicted in Table 1.

Fall on outstretched hand was observed in 21 (50%), direct hit in 11 (26.19%), and road traffic accident (RTA) in 10 patients (23.80%) (Table 2).

Out of 32 right-sided injuries observed, 24 were dominant side, and 8 were non-dominant. In 10 cases of left-sided injury, 6 were non-dominant, and 5 were dominant. Only 1 patient had associated injury fracture both bones of leg due to RTA (Table 3).

The duration between trauma and undertaking surgery varied from 1 to 9 days with a mean duration of 4.35 ± 1.10 days (Table 4).

Table 1: Age and sex incidence (*n*=42)

Age group (years)	Sex		Total
	Male	Female	*n* (%)
20-30	7	3	10 (23.80)
31-40	5	1	6 (14.28)
41-50	8	6	14 (33.33)
51-60	5	4	9 (21.42)
>60	2	1	3 (7.14)
Total	27	15	42 (100)

Table 2: Mechanism of injury observed (*n*=42)

???	No. of cases (%)
Fall on outstretched hand	21 (50)
Direct hit	11 (26.19)
RTA	10 (23.80)
Total	42 (100)

RTA: Road traffic accident

Table 3: Injured side/handedness (*n*=42)

Side	Dominant side	Non-dominant side	Total
Right-32	24	08	32
Left-10	06	04	10

Table 4: Period between injury and surgery

Period (days)	No. of cases (%)
<2	3 (15)
3-4	8 (40)
5-6	5 (25)
7-8	2 (10)
8-9	2 (10)
Total	20 (100)

Most of the patients presented with transverse fractures 24 (57.14%), 11 were oblique (26.18%) and 7 were with comminuted fractures (16.66%) (Table 5).

A total of 36 patients underwent fixation through volar approach (anterior Henry's), (85.71%); remaining 6 patients (14.28%) through dorsal Thomson's approach was used (Table 6).

Seven-holed plates were used in 20 patients (47.61%), 8 holed plates were used in 10 patients (23.80%), and (28.57%) 6 holed plates were used in 12 patients (Table 7).

The duration of immobilization is shown in Table 8.

Complications observed in the present study were superficial post-operative infection in 1 patient, tourniquet palsy in 1 patient, and distal radioulnar joint subluxation in 3 patients. Fracture union took place in 4-6 months. All cases healed clinically and radiologically by 1 year. Four cases union was delayed beyond 9 months (Table 9).

There was a significant correlation between deficits in range of pronation/supination with age groups in the present

Table 5: Type of fracture (*n*=42)

Type of fracture	No. of cases (%)
Comminuted	7 (16.66)
Oblique	11 (26.19)
Transverse	24 (57.14)
Total	20 (100)

Table 6: Surgical approaches used (*n*=42)

Side of the fracure	No. of cases (%)
Volar	36 (85.71)
Dorsal	6 (14.28)
Total	42 (100)

Table 7: Plate length of narrow DCP (*n*=42)

No. of holes	No. of cases (%)
6	12 (28.57)
7	20 (47.61)
8	10 (23.80)
Total	20 (100)

DCP: Dynamic compression plate

Table 8: Length of immobilization (*n*=42)

Length of immobilization	No. of cases (%)
4 weeks	22 (52.38)
6 weeks	14 (33.33)
8 weeks	6 (14.28)
Total	42 (100)

study. Four patients in the age group of above 50 years had pronation supination difference of 30-50°. It was statistically significant ($P < 0.05$) (Table 10). Patients over the age of 50 years are found to have the limitation of wrist flexion-extension range of motion. Four patients in this group had a deficit of 30-50° in the present study. It is statistically significant ($P < 0.05$) (Table 10).

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Four of 42 cases had pain with wrist movements. In this group, 2 had stable distal radioulnar joint and 2 had subluxated distal radioulnar joint (Table 12).

Grip strength was excellent in majority of the patients with stable distal radioulnar joint. Statistical analysis shows significant correlation between grip strength and distal radioulnar joint stability ($P < 0.05$) (Table 13).

The mayo risk score is shown in Table 14.

Table 9: Fracture union in months (*n*=42)

Duration (months)	No. of cases (%)
4-6	13 (65)
7-8	3 (15)
9-10	2 (10)
>10	2 (10)
Total	20 (100)

Table 10: Pronation supination difference age wise (*n*=42)

Pronation supination difference	Age group (years)					Total
	20-30	30-40	40-50	50-60	>60	
0°	9	8	13	5	2	37
10°						
20°				1		1
30°				1		1
50°				2	1	3
Total						42

Table 11: Wrist flexion-extension difference (*n*=42)

Wrist flexion-extension difference	Age group (years)					Total
	20-30	30-40	40-50	50-60	>60	
0°	09	08	13	05	02	37
10°				1		1
20°						
30°				2		2
50°				1	1	2
Total						42

In 14 cases (70%), results were excellent with perfect alignment, stable distal radioulnar joint, and full pronation supination and flexion-extension of the wrist. In 2 cases, results were fair (10%). In 4 cases, results were poor (20%) (Table 15).

DISCUSSION

It has to be agreed with Hughston[3] who said: "We believe that the high percentage of unsatisfactory results in the treatment of this fracture is due to most physicians' lack of knowledge of the forces active when customary reduction with immobilization is applied." Successful treatment of Galeazzi fractures depends on the reduction of the radius and distal radioulnar joint and the restoration of the forearm axis. Hughston[3] outlined the difficulties and complications

Table 12: Pain and distal radioulnar joint stability (*n*=42)

Observation	Distal radioulnar joint stability		Total
	Stable	Subluxated	
No pain	15	1	38
Pain	2	2	4
Total	17	3	42

Table 13: Grip strength, distal radioulnar joint stability (*n*=42)

Grip strength (%)	Distal radioulnar joint stability		Total
	Stable	Subluxated	
60	1	2	5
80	-	1	1
90	9	-	8
100	29	-	6
Total	39	3	42

Table 14: Mayo wrists score

Observation	Number (%)
Excellent	35 (83.33)
Good	2 (4.76)
Fair	2 (4.76)
Poor	2 (4.76)
Total	42 (100)

Table 15: Final results (*n*=42)

Observation	Number (%)
Excellent	37 (88.09)
Fair	3 (7.14)
Poor	2 (4.76)
Total	42 (100)

of non-operative treatment in 1957. An unsatisfactory result was identified in 92% (35 of 38) of patients treated with closed reduction and cast immobilization. This was due to loss of reduction, resulting in malunion. Loss of reduction was attributed to the deforming force of the brachioradialis, the pull of pronator quadratus leading to rotation of the distal radial fragment toward the ulna, and weight of the hand as a deforming force leading to dorsal angulations of the radius and subluxation of the distal radioulnar joint. These deforming forces are unable to be controlled with plaster immobilization, and the operative management is required in these fractures. Radius and ulna are nearly parallel, and they have complex mechanical relationship to one another.[12] Any disproportion in length results in a disturbance of the radioulnar joints. Hence, the fracture of radius must be anatomically reduced and must be maintained throughout the healing period. Moreover, an unstable radioulnar joint should also be reduced and fixed in optimal position. The present study has limitation in comparing exactly with the previous published series. The selection criteria of the patient were different, and the long-term outcome could not be predicted in this study. Hence, the general outcome in Galeazzi fracture-dislocation pursue could not be drawn. The short-term outcome of selected cases is only studied. The present study is similar to that one conducted by Moore *et al.*,[7] Strehle and Gerher,[8] Moore *et al.*,[13] and Bhan and Rath.[14]

The demographic data on our 42 patients indicate that 64.28% of the Galeazzi fracture-dislocation occurred in male patients. Similarly, Mikic[4] found a male preponderance of 74% in males.

A study by Moore *et al.*[7] reported that 80% were males. A male preponderance is not surprising considering the higher risk of violent injury among men.

In this study, the age of the patients ranged between 22 years and 60 years with a mean age of 43.7 years. Most of the patients (50%) were in the third and fourth decades. In the study of Mikic[4] and Moore *et al.*,[7] most of the cases occurred in the third and fourth decades. In the present study, the right side was involved in 32 (76.19%) of 42 cases. Mikic[4] reported 54% of these injuries occurred in left side but did not determine the dominant hand in his patients. Wong[15] found that 23 of his 44 patients had an injury to the right forearm (Figure 1).

In the present study, most of the fractures occurred due to self-fall on outstretched hand, i.e., 21 (50%) of 42 cases. Every third of the patients in the study of Moore *et al.*[7] sustained multiple injuries that were associated with Galeazzi fracture. Obviously, major share of the injury comes from vehicular accidents. In this study, only 10 cases were due to RTA (23.80%). In the present study, in the majority of cases, volar plating by anterior Henry's approach was used in 36 cases (85.71%) (Figures 2 and 3).

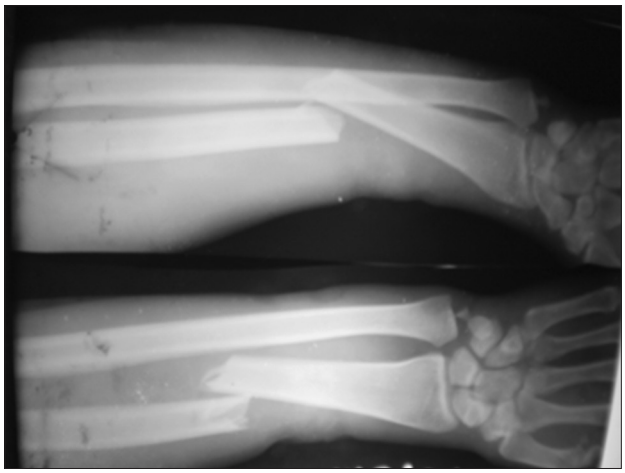

Figure 1: Anteroposterior and lateral views of the distal radial fracture

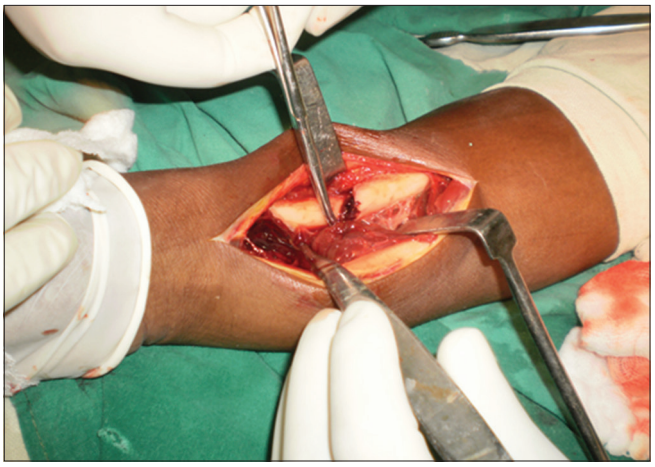

Figure 2: Volar approach

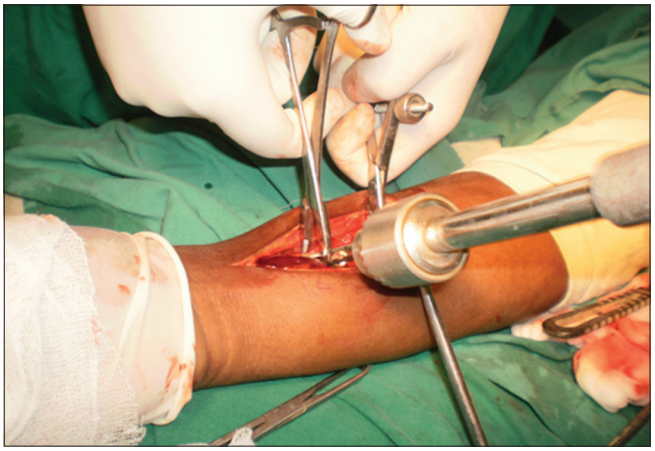

Figure 3: Fracture reduction

Dorsal plating by Thompson approach used only in 6 cases because of superficial abrasion and pinpoint wound over volar side.

A study conducted by Anderson *et al.*[16] found that volar plating is technically easier and results in better soft tissue coverage. However, a plate in this location may mechanically limit pronation. Since supination and pronation were not analyzed separately, we have no data suggesting 1 site of plate application over the other. The treatment outcome of Galeazzi fracture has drastically improved from a high failure rate of 52% with closed treatment[3] to 70-80% excellent result with AO plating. This success rate is inspite of more stringent outcome. We had used 3.5 mm NDCP in all the cases. We had excellent results in 14 patients (70%). A complete dislocation of distal radioulnar joint always involves rupture of articular disc and of the associated dorsal and volar distal radioulnar ligaments. This articular injury as well as the fracture of radius must be dealt with if good results are to be obtained in the treatment of Galeazzi fracture. All studies in this subject have cited the poor results that are obtained when the injuries are treated by closed methods. Houghston[3] suggested immediate resection of distal part of ulna, and Mikic[4] advocated temporary fixation of the distal radioulnar joint, with 1 or 2 K-wires after fixation of the radial fracture site. Anderson *et al.*[16] advised grafting under certain conditions, but this was not done by most authors or in this study. After the fracture of the radius was reduced and plated, no irritability was observed in the distal ulnar joint. Hence, "K" wire fixation was observed. In this series, immobilization of the forearm in full supination was done. In that position, dislocation of distal radioulnar joint reduced, and the torn articular discs and ligaments are approximated. Most of the cases in the present study were immobilized for 4 weeks in 52.38% of 42, 6 weeks in 33.33%, and for 8 weeks in 14.28% of patients. The feared problem of supination contracture was not present in the present study. In a study by Reckling and Cordell,[17] immobilization was done in full supination and continued for 6-8 weeks. In a study by Moore *et al.*,[7] post-operative immobilization in neutral position or 5-10° of supination for 4 weeks was done. There were no pre-operative neurovascular complications in this series. However, such nerve injuries have been described in the previous studies.[18,19] Unfortunately, high frequency of intraoperative nerve injuries was seen in the series of Moore *et al.*[7] Anderson *et al.*[16] reported 7% and Dodge and Cady[20] reported 10% frequency of nerve injury in their series. Stern and Druny[21] reported no such injury (Figure 4).

In this study, there were no intraoperative nerve injuries. The radial sensory nerve was the most common branch injured and associated with Henry's approach.[18]

Moore *et al.*[7] in their study of 36 Galeazzi fracture noted a complication rate of 39%. The complication rate in Strehle and Gerher[8] series was 32%. In the present series, the complication rate was 25%. In this study, 3 cases of radioulnar joint subluxation, 1 case of tourniquet palsy, and 1 case of superficial post-operative infection were observed. Older people in the present study were found to have movement restriction in flexion-extension and pronation-supination. Pronation-supination difference of 30-50° was noted in 4 patients above the age of 50 years when compared to the opposite side. A similar degree of flexion-extension limitation noted in 4 patients over 50 years of age (Figure 5).

Uniformly, good results have been obtained by open anatomical reduction, internal fixation of the radial fracture, and immobilization of the forearm in full supination. Temporary fixation of distal radioulnar joint with K-wire or repair of triangular fibrocartilage complex is rarely if ever required after open reduction and internal fixation of the radius and immobilization.

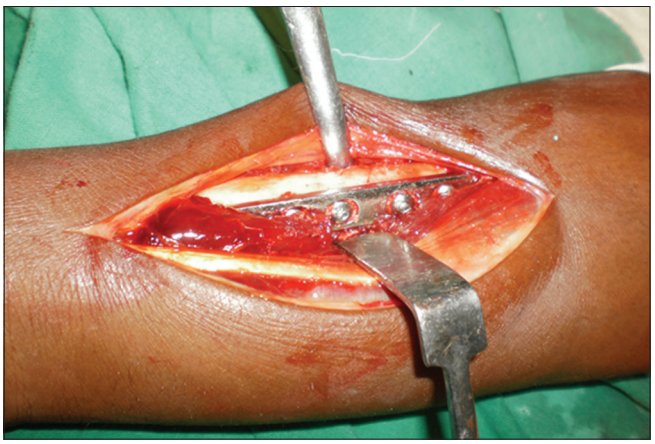

Figure 4: Fracture reduction

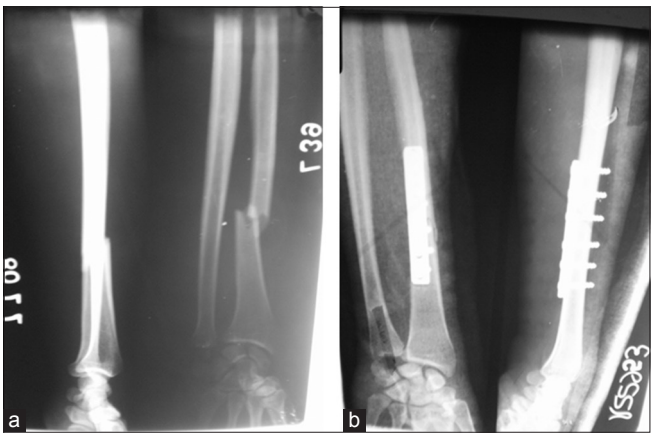

Figure 5: (a and b) Pre- and post-operative X-rays of Lower radial fracture

CONCLUSION

The key to the satisfactory results in the treatment of the Galeazzi fractures is anatomic restoration of length of the radius with application of rigid internal fixation to maintain the reduction. Open revision and K-wire fixation of distal radioulnar joint are not necessary if anatomic reduction of the joint is obtained by indirect means such as open reduction and internal fixation of the radius and immobilization.

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