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Surgical Treatment of Ipsilateral Fracture Lower Radius and Fracture Dislocation of the Carpal Bone: Case Series

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Abstract

Background: Pathoanatomy & biomechanics of radiocarpal & radioulnar joints have pivotal role in maintaining wrist functions and movements. Problems associated with these fractures hamper strength of grip and early arthritis with carpal instability.

Patients and methods: Twenty four patients with unilateral distal radius fracture associated with intercarpal fractures and dislocations who were managed by treatment protocol of primary external fixation for ligamentotaxes until edema subsided, followed by secondary stage of plate fixation of distal radius, k-wire fixation of intercarpal ligamentous injury, and Headless compression screw fixation for carpal scaphoid fractures. The patients were evaluated according to standard objective and subjective criteria using demerit-point system of Gartland and Werley & patient rated wrist evaluation score (PRWE).

Results: Fourteen patients (70%) had excellent to good outcome based on Gartland and Werley score, and six patients had fair outcome. Radiologically, excellent to good results were found in 80% of the patients with loss of radial inclination less than 10 degrees, average radial shortening (4mm) ranged from 3-6 mm. The average palmar tilt at final follow up was around 7 degrees (3-14).

Conclusion: The technique of primary external fixator, followed by plate osteosynthesis can be utilized in comminuted intra articular fractures lower radius associated with screw fixation for individual carpal bone fixation and k wire for intercarpal instability due to ligamentous injuries. The adequate surgical technique will minimize complications and an optimized rehabilitation regime can give the best possible result. Accurate anatomical reduction of the articular surface and stable fixation are mandatory for better functional outcome.

Keywords: fractures, lower radius, Carpal Bone, surgical treatment

Introduction

The wrist is a complex joint consisting of bony structures, including the distal radius, distal ulna, and eight carpal bones and a ligament complex that divides extrinsic and intrinsic ligaments. Pathoanatomy & biomechanics of radiocarpal & radioulnar joints have pivotal role in maintaining wrist functions and movements [1-3]. Problems associated with these fractures hamper strength of grip and early arthritis with carpal instability [4]. Therefore, the prognosis of wrist injuries can be affected by soft tissue injuries as well as fractures [5]. Distal radial fractures (DRFs) are common injuries that occur in the upper limb and are treated using various methods, including closed reduction and cast immobilization, percutaneous K-wire fixation, external fixation, intramedullary fixation, and open reduction and internal fixation [6-9]. However, previous studies have been mostly limited to fractures that occur in the distal radius with associated fractures in the distal ulna. Some studies have reported that associated soft tissue injuries may affect the outcome of DRFs.

As soft tissue injuries may be accompanied by DRFs, carpal bone fractures (CBFs) may occur in association with DRFs. Avulsion fractures of carpal bones are commonly observed in patients with DRFs and may indicate injuries to the intrinsic or extrinsic ligaments of the wrist [10]. Additionally, CBFs may be untreated, because CBFs are frequently missed on initial radiographs, which may lead to persistent pain or subsequent wrist dysfunction and eventually affect the outcome of DRF treatment [11-13]. If associated CBFs are misdiagnosed and left untreated, unsatisfactory DRF clinical outcomes may occur. Therefore, associated carpal injuries must be ruled out for DRFs. However, the frequency and distribution of CBFs associated with DRFs have not been reported, since cases of scaphoid fractures accompanying DRFs are usually reported [14].

The aim of this study was to evaluate the clinical and radiological results of 20 patients with associated fracture distal radius and ipsilateral intercarpal fracture dislocation of the wrist and intercarpal joints. The treatment protocol was immediate external fixation (5-7 days), followed by secondary stage open reduction and multiple angle anatomical locked plate fixation of distal radius with intercarpal k-wires and Headless 2.7 mm compression screws for scaphoid fixation and follow up of minimum period of one year.

Patients and Methods

In the period from May 2014 to November 2018, twenty four patients with unilateral distal radius fracture associated with intercarpal fractures and dislocations who were managed by treatment protocol of primary external fixation for ligamentotaxes until edema subsided, followed by secondary stage of plate fixation of distal radius, k-wire fixation of intercarpal ligamentous injury, and Headless compression screw fixation for carpal scaphoid fractures.

At the end of 36 months follow up 20 of 24 patients underwent clinical evaluation of minimum 1 year follow up were finally included in this study. There were 16 males and 8 females, with an average age of 33 years (range 22-45 years). There were 6 dominant hands and 14 nondominant hands with fractures. Four fractures were due to fall on the ground and 16 fractures were due to road traffic accidents. All patients who underwent preoperative plain X-ray and computed tomography (CT).

According to the Müller-AO comprehensive classification [15], there were 3 fractures Type A, 5 were Type B, and 12 were Type C. The Type C fractures included 6 C1 fractures, 4 C2 fractures, and 2 C3 fractures. The operative procedure was started within 3 days of injury. The average time interval between injury and final surgery was 23 days (range 14 - 21 days). We used the Gartland and Werley scoring system [16] for assessment of functional outcome with modification based on Sarmiento et al.'s criteria of the minimum in range of motion (ROM) for normal function, which consisted of extension (45°), flexion (30°), radial deviation (15°), ulnar deviation (15°), pronation (50°), and supination (50°). Standard preoperative and postoperative postero-anterior and lateral wrist radiographs were obtained for each patient. We recorded radiographic parameters such as the degree of volar angulation, radial inclination (RI) angle, and radial height (RH). Routine follow-up radiographs were taken in the clinic at 4 weeks, 3 months, and 1 year after surgery.

Statistical analysis with a two-sample t-test was used to determine the significance of differences in radiographic parameters between postoperative radiographs and those of the 1-year follow up. A significant difference was defined as a $P < 0.05$.

Surgical Technique

After the primary period of external fixation (5-7 days), the final operation was done after extraction of the fixator and sterilization. 12 operations were performed under regional anesthesia, and 8 patients under general

anesthesia. Distal radius fractures were reduced and fixed temporarily by K-wire (K-wire) after realignment was confirmed using C-arm image intensifier. Two K-wires were used to secure the dorsal lunate facet fragment for correction of dorsal angulation. Another two were used to fix the radial styloid fragment for maintenance of radial height (RH). Volar plate through hennery approach was done in 14 cases and double plate technique was done in 6 cases. For intra articular fractures involving the scaphoid or lunate fossa, capsulotomy was performed through the same incision to allow direct visualization and facilitate restoration of articular congruity. Appropriate size plate selected and placed over volar surface of radius below the watershed line and temporarily fixed with cortical screw under radiological guidance. After confirming the desired reduction, remaining screws are fixed (Figure 1 & 2). Pronator quadratus was repaired using absorbable sutures. Subcutaneous and skin closure was done. Intravenous antibiotic was given for 5 days and then changed to oral post op dressing was done on 3rd post of day and stich removed after 14 days. Postoperatively radiographs were taken, the limb was kept elevated in below elbow plaster slab, active finger, forearm rotation and shoulder exercises were started at the earliest possible. The plaster slab was removed within 4 weeks, crepe bandage applied and active exercises of wrist, elbow and shoulder were started. Range of motion of fingers started immediately but wrist started after 15 days. Heavy lifting was not allowed until signs of fracture healing were radiographically confirmed. Patients were followed up at regular intervals clinically and radiologically. The patients were evaluated according to standard objective and subjective criteria using demerit-point system of Gartland and Werley & patient rated wrist evaluation score (PRWE).

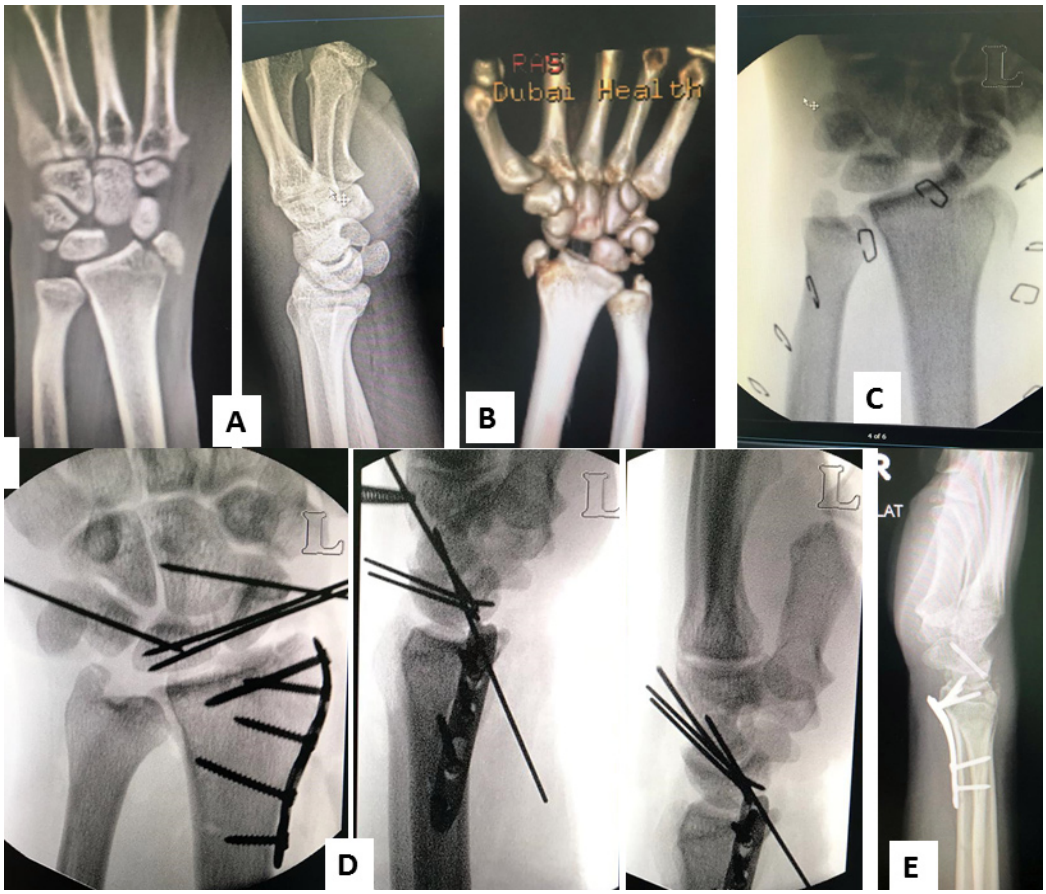

Figure1

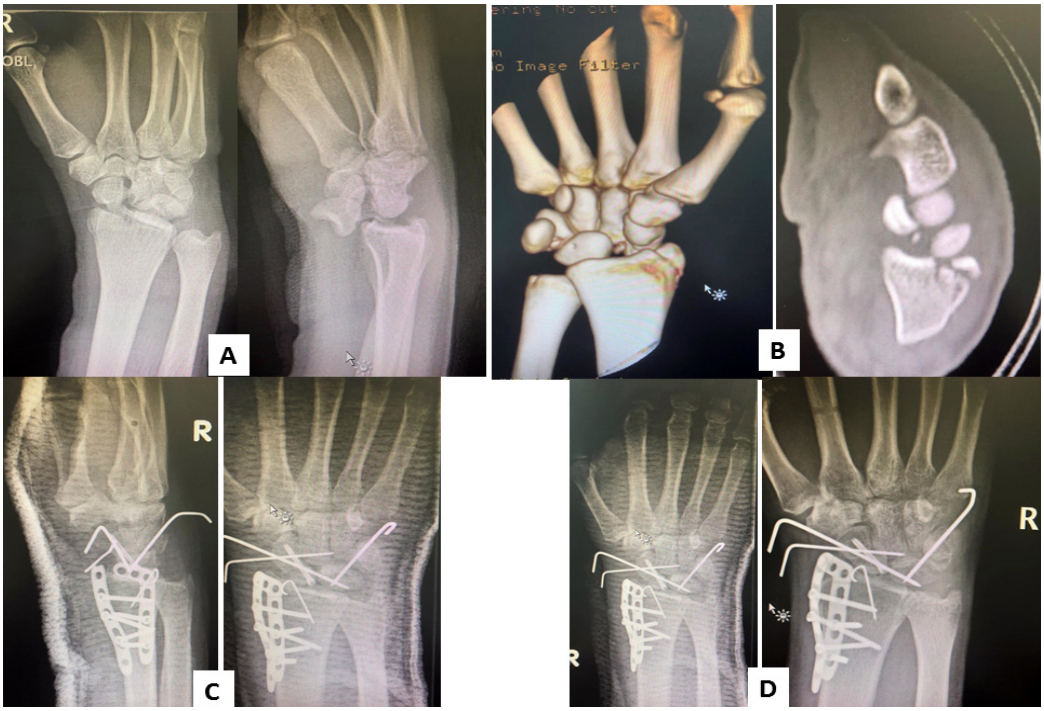

Figure2

Results

Clinically

The average palmar flexion at final follow up was 72 degrees (range: 65-75). There were 90 % of patients having excellent to good palmar flexion range at wrist, and two patients have fair outcome presented as residual dorsal tilt at final follow up. The average dorsiflexion was 78 degrees (range: 75-82 degrees). 85% of the patients have excellent to good results in terms of range of dorsiflexion at wrist at final follow up. The average supination was 80 degrees (range: 78-85 degrees). There were 80% of patients having excellent to good supination range at wrist joint at final follow up. The average pronation at final follow up was 76 degrees (range: 74-80 degrees). There were 88% of the patients had excellent to good radial deviation range at wrist at final follow up with range from 10-18 degrees with average 12 degrees. The average ulnar deviation at final follow up was 25 degrees (range of 20-30 degrees).

Fourteen patients (70%) had excellent to good outcome based on Gartland and Werley score [--], and six patients had fair outcome.

Radiologically

Plain X-rays of the patient were evaluated for Radiological assessment of [Radial inclination, Radial shortening and Palmer tilt]. Excellent to good results were found in 80% of the patients had with loss of radial inclination less than 10 degrees (Figures 3 & 4 & 5). The average radial inclination at final follow up was 16 degrees. All the patients in this study had less than 6 mm radial shortening with average (4mm) ranged from 3-6 mm at final follow up. The average palmar tilt at final follow up was around 7 degrees (3-14). There were 60% patients had excellent to good results with regard to loss of palmar tilt less than 6 degrees (range: 3-7), and 8 patients showing loss of palmar tilt upto12 degrees (10-14) and had fair outcome which may be due to dorsal comminution and dorsal collapse on subsequent follow up. We noted in patients with fair outcome that they

had dorsal tilt at final follow up and observed prominence at ulnar styloid in 3 patients (15%), residual dorsal tilt in 1 patients (5 %), reflex sympathetic dystrophy in 1(5 %) patient and hand grip strength weakness in 1(5 %) patient.

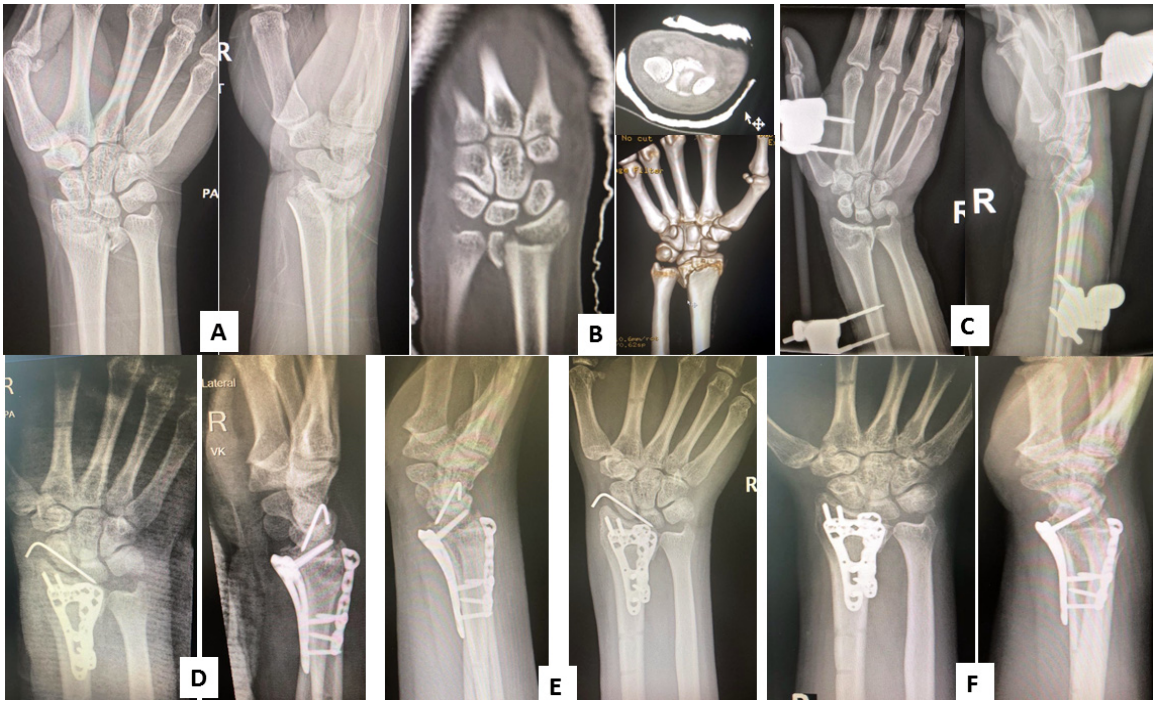

Figure3

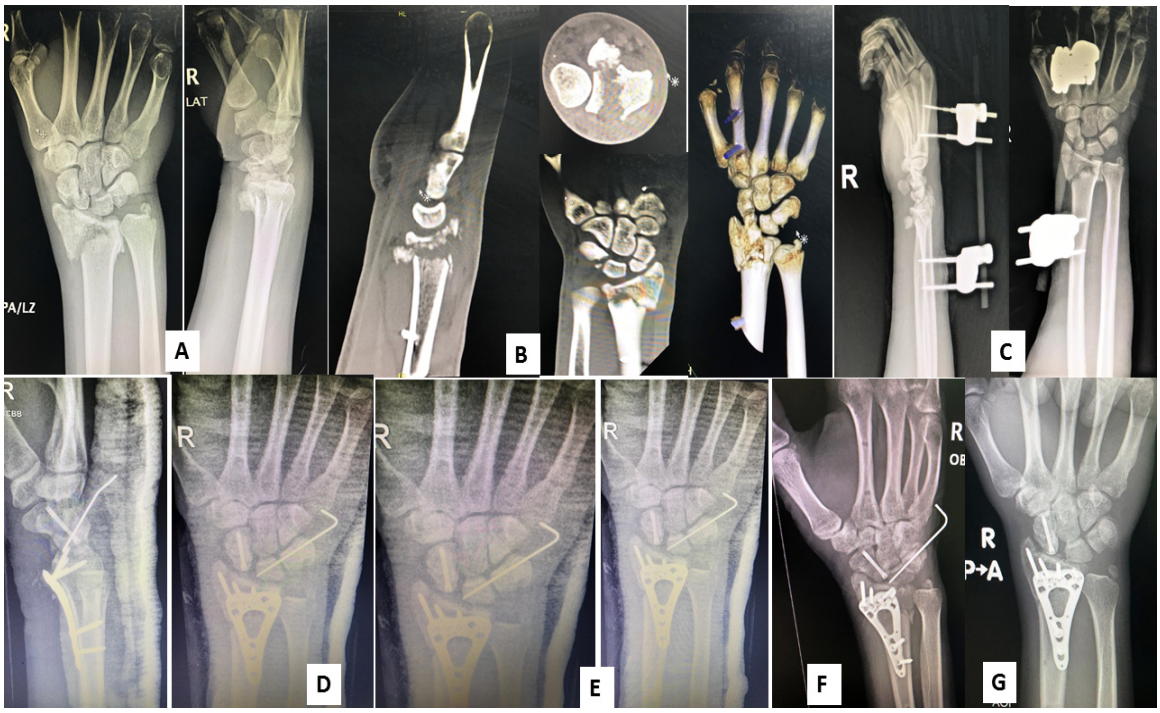

Figure4

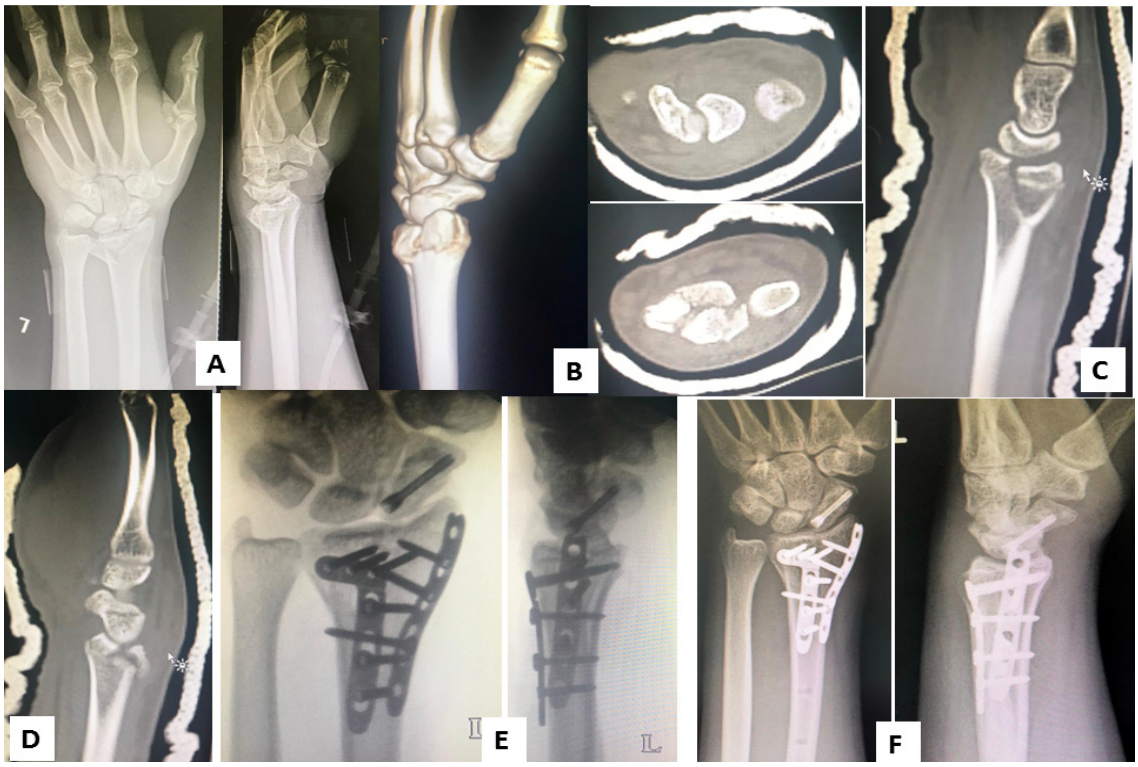

Figure5

Discussion

To allow early restoration of function, the surgery for unstable distal radius fracture should obtain an acceptable reduction, with the articular congruity maintained. Achieving fracture stability is mandatory for attaining a satisfactory outcome for distal radius fractures [4-7]. The increased risk for loss of reduction and subsequent malunion can potentially lead to poor function and residual pain, stiffness, loss of grip strength, and intercarpal instability.

The association of intercarpal fractures or fracture dislocations and distal radius fracture can affect the results specially when neglected [17-19]. The stability between carpal bones is maintained by extrinsic and intrinsic ligaments. The diagnosis of carpal bone fractures (CBFs) can be difficult with only plain x-ray.

Neglected CBFs can lead to complications including carpal instability, avascular necrosis, nonunion, malunion, articular incongruity, or post-traumatic arthritis resulting in persistent pain and compromised functional results. All CBFs, except those of the scaphoid, are more difficult and have lower sensitivity for detection on plain radiographs, the need for specific radiographic views or CT is recommended to assess complex wrist fractures or when initial radiographs are equivocal [20-23]. In this study, the diagnosis was confirmed by CT in all cases. In such associated injury, it is important to be careful in the initial management especially during manipulation of the distal radial fracture to reduce the risk of displacement of the initially nondisplaced scaphoid fracture or ligamentous injuries. In our work external fixator was done routinely for 5 to 7 days before final treatment.

In the literature, the scaphoid accounts for about 70% of all CBFs, and the remaining carpal bones account for about 30%. More than 90% of CBFs are found in the proximal carpal row [1-3]. In this study, 80% of CBFs occurred in the proximal row of the carpals. The complication rates of DRFs in previous studies vary from 6% to 80%. The clinical result of DRFs may be influenced by injury severity, any associated soft-tissue trauma,

and treatment method [24]. Most reports regarding simultaneous CBFs and DRFs are scaphoid fractures, which account for 0.75%–6.5% of all DRFs. Stable internal fixation of scaphoid fractures and DRFs is generally performed for early mobilization of the wrist joint and to avoid complications such as scaphoid nonunion [25-27].

Pretell-Mazzini and Carrigan [21] reported simultaneous DRFs and carpal bone injuries in children. They emphasized that orthopedic surgeons must first rule out CBFs because the mechanism of injury is similar for both fractures, and inappropriate treatment may lead to unsatisfactory outcome. Most other CBFs, except scaphoid fractures, can be treated by immobilizing the patient for 4–6 weeks [20-24].

In this study, all CBFs were surgically managed. In accordance with the development of a locking plate for DRFs, however, early mobilization of the wrist joint is often performed after the operation for the DRF. For ligamentous injuries of intercarpal joints K-wires were used for 6 weeks to maintain the reduction and stability. We generally immobilize all DRFs for about 4 weeks after surgery using a locking plate.

In a comparison study between an early motion group and a late motion group by Lozano- Calderon et al [28], no significant differences in range of motion, grip power, or clinical scoring were observed. Therefore, we believe that immobilization for an appropriate period after surgery is necessary. The different methods for treatment of DRFs with associated CBFs were volar plate fixation, dorsal plate fixation, external fixation, screw fixation for carpal bones, and percutaneous K-wire fixation. Recent studies show further improvement in functional outcome of ORIF owing to advances in implants and surgical techniques [3, 7, 21, and 27].

Egol K et al. [29] conducted a prospective randomized study involving 88 cases. Although the patients treated by plating had significant early improvement in the range of movement of wrist, in absolute terms the difference in range of movement was clinically unimportant. At one year radiological, clinical and functional outcome were similar in two groups.

Mechanical studies using an unstable and intra articular distal radius fracture model have demonstrated that dual low profile plates, when placed at 50-90 degree angles to each other in the axial plane, provide fixation that is statistically superior. The concept of two or more low profile implants placed strategically along the columns of the distal radius to fix individual fracture fragments [11]. Benson et al. [30] reported an 85 intra articular fractures stabilized with fragment specific fixation with 32 months follow up documented 85% flexion, 91% extension, 64 excellent, 24 good results and no cases of symptomatic arthritis.

In this study, the clinical results for twenty patients were fourteen patients (70%) had excellent to good outcome based on Gartland and Werley score, and six patients had fair outcome. Radiologically, excellent to good results were found in 80% of the patients with loss of radial inclination less than 10 degrees, average radial shortening (4mm) ranged from 3-6 mm. The average palmar tilt at final follow up was around 7 degrees (3-14). We noted in 3 patients (15%) that they had dorsal tilt at final follow up and observed prominence at ulnar styloid.

Conclusion

The frequency of CBFs increased in severe fracture types such as AO types C2 and C3, and 90% of the DRFs with associated CBFs were classified as these two types. Misdiagnosed or untreated associated CBFs may affect the final outcome. Therefore, CT scan for the detection or exclusion of CBFs of is required in management, as plain radiographs are insufficient for a definitive diagnosis of associated CBFs. The technique of primary external fixator, followed by plate osteosynthesis can be utilized in comminuted intra articular fractures lower radius associated with screw fixation for individual carpal bone fixation and k wire for intercarpal instability due to ligamentous injuries. The adequate surgical technique will minimize complications and a optimized rehabilitation regime can give the best possible result. Accurate anatomical reduction of the articular surface and stable fixation are mandatory for better functional outcome.

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