REVIEW
OF
LITERATURE
Since time immemorial man has been beset by problems of accidents and injuries and has been trying to effectively cope with them. It will not be improper to say that the history of fractures and their treatment dates back to the advent of human race on this planet. Since no mode of recording the events existed in those times, there are no data on the method of treatment practiced during that period. Some glimpses of the knowledge that existed are however possible through the various scriptures that came into being subsequently.

The earliest reference of healing of bone is found in Vedas (2000 BC). Samhitas of Charak and Shushruta (1000 BC) deal with diagnosis and treatment of fractures and dislocations. Since the dawn of civilization man has recognised the importance of immobilization in the treatment of fractures.

The traumatic lesion were fairly common in ancient Egypt. A study of six thousand skeleton of all ages of 3400 BC to early Christian era show that one hundred sixty cases of fractures were seen and most common fracture was of forearm fracture (31%). The splints were made of the mid rib of the date palm leaf, bark of the acacia tree or bundles of straw from coarse grass.

From the time of Hippocrates to the beginning of eighteenth century the so commonly encountered fractures of
distal end of radius were not recognised and were mistaken for luxation, subluxations of the wrist or separations of the distal radioulnar joint. Possibility of occurrence of such fractures was first mentioned by Petit (1705), but the description in literature came only in 1783 when Pouteau’s work was published posthumously entitled “Continent quelques reflexions sur quelques fractures deal avantbras sur les luxatiojns incomplete due poignet et sur les diastasis” in which he described the fracture of distal end of radius with posterior tipping or displacement of the distal fragment. He also recognised that there were several other types of fractures of the distal radius, some of which were impacted and did not exhibit crepitus.

Little attention was paid to Pouteau’s work outside France, so Sir Abraham Colles (1773-1843) was unaware of it when he published his paper "On the fractures of carpal extremity of the radius" in 1814. He described a fracture which takes place about an inch and a half above the carpal extremity of radius in which the distal fragment is displaced backwards. His description was on the deformity which appears with such displacement (Swelling on dorsum of wrist with a depression in forearm above fracture site, fullness of wrist on volar side and head of ulna projecting anteriorly). Colles’ work got attention in his country as well as outside and till today the posteriorly displaced fractures of distal end of radius are called Colles' fractures.
Alfred Armand Velpeau (1795 - 1866) termed the usual deformity seen in fractures of the distal end of the radius "the talon de four chette" which translated into English meant the silver fork deformity. John Rhea Barton (1784 - 1871) in an article entitled "Views and treatment of an important injury to the wrist" in 1838, described fracture dislocations of the radiocarpal joint. The fracture could be of either the dorsal or the volar side of the radial articular surface with dislocation of the radiocarpal joint. The fracture could be of either the dorsal or the volar side of the radial articular surface with dislocation of the wrist in same direction. Such fractures are known as dorsal Bartons' fracture dislocations depending upon the direction of the dislocation. Robert William Smith (1857) described fracture of the lower extremity of the radius with displacement of lower fragment forwards, known as Smith's fracture.

During the interval between the introduction of the automobile and the perfection of electric starter (1900 - 1925), another type of fracture became popular i.e. "Chauffeur's fracture" sometimes called the "backfire fracture". This injury was the result of a backfire occurring on either the downward swing or upward pull of crank while starting the car. These fractures received a great deal of attention but no specific or characteristic type of fracture resulting from this mechanism could be defined.

Three rather well defined eponymic fractures can be distinguished from fractures of the distal end of the radius-Colles'
(Pouteau-Colles' in France), Barton's fracture dislocations and Smith's fracture.

Intra-articular fractures became separate entities when Nissen Lie (1939) and Rogers (1944) classified these fractures as a separate group. These are getting increasing attention due to associated high risk of redisplacement and secondary Osteoarthritis of wrist or inferior radioulnar joint. In most of the standard classifications, intra-articular fractures have been kept in separate group. Melone (1984) has classified these fractures into four types which help in deciding about the type of treatment. Most of the recent published reports are on treatment of these fractures among which external fixators, the one devised by Clyburn (1987), the so called dynamic external fixator seems to be superior to others, as it allows wrist movements also.

Comminuted fractures also became a separate entity when it was realised by Taylor & Parson (1938), Nessen Lie (1939), Anderson (1944), Green (1975), Stein (1978) and several other authors that these fractures have tendency to re-displace in plaster and lead to loss of radial length and angles after manipulation. Several attempts have been made to prevent this by using the methods like pin incorporation in plaster; percutaneous pinning or external fixators with good to remarkable results.
The term unstable fracture of the distal end of radius was initially considered synonymous to comminuted fractures but Cooney (1979) defined it clearly. According to him the unstable fractures of the distal end of the radius are the fractures which have either one or more of the following features:

1. Dorsal angulation more than $20^\circ$.
2. Presence of comminution.
3. Intra-articular extension.
4. Loss of reduction with dorsal angulation more than $5^\circ$.
5. Radial shortening more than 5mm.

**ANATOMY OF LOWER END RADIUS:**

The distal radius functions as an articular plateau upon which the carpus rests, and from which the radially based supporting ligaments of the wrist arise. The hand and radius, as a unit, articulate with and rotate about the ulnar head via the sigmoid notch of the radius. This relationship is maintained primarily by the ulnar-based supporting ligaments of the wrist: The triangular fibrocartilage complex.

The distal radius has three concave articular surfaces the scaphoid fossa, the lunate fossa, and the sigmoid notch for articulation with the scaphoid, lunate, and ulnar head, respectively. The scaphoid fossa is basically triangular in shape with its apex forming the radial styloid. An anterior/posterior ridge separates this fossa the smaller lunate fossae. Both fossae are concave in the anterior/posterior plane and the
medial lateral plane. The sigmoid notch is concave, with a poorly defined proximal margin and well-defined dorsal, palmar, and distal margins.

The metaphyseal flare of the distal radius begins approximately 2 cm above the distal articular surface. As the radius flares, the thickness of the cortical bone decreases and the amount of cancellous bone increases. The distal articular surface of the radius has a radial inclination or slope of an average 22 degrees, had tilts palmarly an average of 11 degrees. Radial inclination is measured by the angle drawn between a line tangential to the distal radial articular surface on a PA x-ray and perpendicular to the shaft of the radius. Palmar tilt is measured by the angle between the plane of the distal articular surface as seen on the lateral x-ray and a perpendicular to the longitudinal axis of the radius. The sigmoid notch angles distally and medially an average of 22 degrees to from the "seat" for the ulnar head.

The palmar radial aspect of the radius is felt, with vascular foramina. From this surface arise the major radial supporting ligaments of the wrist the radial collateral, radiocapitate, and radiotriquetral ligaments. At the palmar aspect of the anterior/posterior midradial ridge there is a tubercle for the origin of a very important radioscapoholunate ligament, or Ligament of Testut. The dorsal aspect of the distal radius is somewhat convex, acting as a fulcrum for extensor tendon function. The radial styloid area, at times has a groove for the tendon of the
first dorsal compartment and ulnar to this a dorsal longitudinal prominence, Lister's tubercle, which acts as a fulcrum for the extensor pollicis tendon. Relatively weak and unimportant supporting ligament arise from the dorsal radial aspect of the radius, these are the radioscapoid and radial triquetral ligament. Along the entire ulnar aspect of the distal articular surface of the radius, at the distal margin of the sigmoid notch, the triangular fibrocartilage complex arises. This ligamentous complex, the major stabilizer of the distal radioulnar joints and ulnar carpus extends ulnarily to insert into the base of the ulnar styloid and distally to the lunate (the ulnolunate ligament), into the base of the fifth metacarpal.

Normally the wrist is an extremely mobile joint, capable of 120 degrees flexion and extension and 50 degrees radial and ulnar deviation. Forearm rotation of up to 150 degrees occurs at the distal radioulnar joint as the distal radius and its fixed member (the hand), rotate about the ulnar head.

Studies have shown that the radius, through its articulation with the lateral carpus, carries approximately 80 percent of the axial load of the forearm and that the ulna, through its articulation with the medial carpus, via the triangular fibrocartilage complex (TFCO), about 20%. Changes in the forearm unit length ratio, as seen with a settled distal radius fracture, increase radial loading beyond physiologic limits.
Despite the loads borne by the distal radius and the wide range of motion to which the wrist is subjected, a precise relationship is normally maintained among the various component of the wrist joint. This intrinsic stability is the result of the inherent geometry of the distal articulations and their surrounding ligamentous supports.

The methods of treatment of all distal radial injuries is one that attempts to restore as closely and quickly as possible these normal anatomic relationship, within the obvious constraints of the patient's age and general medical condition.

Methysen (1852) a Dutch Scientist was first to use and popularised plaster of Paris bandage and recommended that fractured limb had to be immobilized with one joint proximal and one joint distal till complete union. The first illustration of cramer wire for splintage was found in 1745.

MECHANISM OF INJURY

Most often from fall on outstretched hand. In experimental condition 105 Kg to 440 Kg with mean of 195Kg for women and 282 Kg for men are required to produce fracture. Fracture produced when the dorsiflexion at wrist varies from 40 to 90. Lesser amount of force required at lower angle. Axial loading with dorsiflexion at wrist creates high tensile stress in the palmar radiocarpal ligament which transmit the tensile loading to the anterior cortex, later breaks sharply. If deforming force continues the fracture propagate dorsally where bending
moment induces compression stress which results, in varying degree of rotation, comminuation and impaction. Lateral traction which is exerted on styloid process of the ulna through triangular ligament. In the course of abduction injury produces fracture of ulnar styloid process at its base thus diastasis of inferior radioulnar joint.

CLASSIFICATION

Previously recognition of fracture of distal end radius had been made by various eponyms e.g. :

1. Colles' Fracture - Most common fracture through lower metaphysis within 2cm of articular end.

2. Smith's Fracture - Reverse colles fracture with dorsal angulation, volar displacement of distal fragment produces Garden spade deformity.

3. Barton's Fracture - Fracture dislocation or subluxation in which the rim of distal radius, dorsally or volarly, is displaced with the hand and carpus thus dorsal Barton or Volar Barton respectively.
**Frykman classification of distal radius fracture (1967)**

<table>
<thead>
<tr>
<th>Fracture</th>
<th>Distal Ulnar Fracture</th>
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<tbody>
<tr>
<td>Extra articular</td>
<td>I</td>
</tr>
<tr>
<td>Intra articular</td>
<td>III</td>
</tr>
<tr>
<td>Radio- carpal joint</td>
<td>V</td>
</tr>
<tr>
<td>Radio-Ulnar joint</td>
<td>VII</td>
</tr>
<tr>
<td>Radio-Carpal and Radio-Ulnar joints</td>
<td>VIII</td>
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</tbody>
</table>

The Frykman types III to VIII fractures are prone to complications unless accurate, careful reduction and well controlled immobilization program were followed. Weakness of Frykman's classification: It didn't make distinction between displaced and non-displaced Intra-articular fractures for which treatment modalities varies widely.

**Gartland And Werley Classification (Sermiento Modification 1975):**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Radio-graphic Appearance</th>
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<tbody>
<tr>
<td>Type IA</td>
<td>Extra articular</td>
</tr>
<tr>
<td>Type II</td>
<td>Intra articular</td>
</tr>
<tr>
<td>Type III</td>
<td>Intra articular, displaced</td>
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<tr>
<td>Type IB</td>
<td>Extra articular, displaced</td>
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</tbody>
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In 1990 at a symposium conference on fracture of distal end of radius, a new treatment related classification was proposed i.e. Universal classification based on the principle of extra articular versus intra articular & stable unstable fracture.

Universal Classification : Modified Gartland and Werley Classification (1990)

<table>
<thead>
<tr>
<th>Type</th>
<th>Classification of Fracture</th>
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<tbody>
<tr>
<td>Type -I</td>
<td>Non articular, non displaced</td>
</tr>
<tr>
<td>Type-II</td>
<td>Non articular, displaced</td>
</tr>
<tr>
<td>A</td>
<td>Reducible stable</td>
</tr>
<tr>
<td>B</td>
<td>Reducible unstable</td>
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<tr>
<td>C</td>
<td>Irreducible</td>
</tr>
<tr>
<td>Type -III</td>
<td>Articular, non displaced</td>
</tr>
<tr>
<td>Type -IV</td>
<td>Articular, displaced</td>
</tr>
<tr>
<td>A</td>
<td>Reducible stable</td>
</tr>
<tr>
<td>B</td>
<td>Reducible unstable</td>
</tr>
<tr>
<td>C</td>
<td>Irreducible</td>
</tr>
<tr>
<td>D</td>
<td>Complex</td>
</tr>
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</table>

The reducible fracture are those which can be reduced by ligametotaxis. The unstable fracture those with Dorsal angulation >20°, Dorsal Comminution, Radial Shortening > 10mm, plus distal radio ulnar joint involvement. While secondary unstable fracture are those with residual dorsal
angulation >10° with radial shortening >5mm, and reducible intra-articular fractures are those with radio carpal step off less than 2mm, Dorsal tiling less than 10°, radial shortening less than 5mm.

The ASIF classification of distal forearm fracture is based on ABC system:

A. Extra articular Metaphyseal Fracture,

A1. Extra articular fracture of the ulna, radius intact
   1. Styloid process
   2. Metaphyseal simple
   3. Metaphyseal multi fragmentary.

A2. Extra articular fracture of the radius simple and impacted.
   1. Without any tilt.
   2. With Dorsal tilt. (Colles)
   3. With volar tilt (Boyrand-Smith)

A3. Extra articular fracture of the radius multifragments.
   1. Impacted with axial shorting.
   2. With a wedge.
   3. Complex.
B. Partial articular fracture

B1. Partial articular fracture of the radius, segmental
B2. Partial articular fracture of radius dorsal rim (Barton).
B3. Partial articular fracture of the volar rim (Smith)

C. Complete articular fracture

C1. Complete articular fracture of the radius, articular simple, Metaphyseal simple.
C2. Complete articular fracture of radius, articular simple, Metaphyseal multi fragmentary.
C3. Complete articular fracture of radius Multifragmentary.

CLINICAL PRESENTATION:

Fractures of the distal end of radius comprise 60% of total fractures of the radius out of which 60% to 80% have Radiocarpal, radioulnar or both joint involvement (De Plma 1952; Scheck 1962; Cooney 1979 and 1980; Frykman 1967; and Melone 1984). Colles Fractures are the commonest Borton fracture dislocation are rare King (1975) reported incidence of 1.3% the volar type being 1.5 times commoner than dorsal.

Intra articular fractures occur as a result of high velocity trauma in which the patient usually falls on out stretched hand. Associated injuries such as intercarpal ligament injury in 5%,
fracture of scaphoid in 4% and fracture of ulnar styloid process occurs in 55% cases (Melone 1984). Both comminuted intraarticular and Bartons' fractures occur more commonly in young adults (Deoliviera 1973, King 1975 and Melone 1984) and have predilection for males.

Pain and swelling Develop immediately after injury in all fractures. In posteriorly displaced fractures (Colles' and dorsal Barton's) the hand seems displaced posteriorly at wrist and there is fullness on dorsal aspect giving rise to dinner fork deformity is more severe in Colles' fracture and less in dorsal barton's fracture dislocation. The inferior radio ulnar joint is disrupted and triangular cartilage is torn in many cases. The ulner collateral ligament is eighter ruptured or the ulnar styloid process is avulsed. The head of ulna becomes more prominent medially and volar words. The deformity in antiorly displaced fractures (Smith's and Volar Barton's fracture dislocation) is likened to a garden spade, there being a dorsal prominence over the distal end of the upper fragment and a fullness of the wrist on the volar aspect due to displaced distal fragment. The head of the ulna becomes prominent on the dorsum of the wrist. This deformity is severe in Smith's fractures but less marked in volar Barton's fractures locations. Crepitus is usaully present at the fracture site but may be absent in impacted undisplaced fractures, the fractures are closed (simple) in 98.7% cases (Bacorn, 1953). Associated carpal tunnel syndrome can be present and the patient should be evauluted for the same. As
these injuries are caused by high velocity trauma the whole body should be examined properly to rule out other injuries.

RADIOLOGICAL PRESENTATION

Standard postero-anterior & lateral radiographs of wrist are taken. Oblique views are rarely needed but should be done to rule out scaphoid fractures. In posteriorly displaced intra-articular fractures the postero-anterior view shows loss of radial length and radial angle with subluxation or dislocation of distal radio-ulnar joint with or without avulsion fracture of ulnar styloid process. Commination varying from minimal to very severe with fracture lines extending into radiocarpal or radio-ulnar joints can be seen. In lateral view the normal volar tilt is lost and head of the ulna is seen on anterior aspect. In anteriorly displaced intra-articular fracture findings in PA view are similar to above mentioned fracture but lateral view shows increase in volar tilt and head of ulna is seen dorsally.

Various radiographic parameters, On PA & lateral view film have been used for assessment of position of fracture fragments.

The following measurements will be taken according to Lid storms.
A) Radial Angle :- It is an angle sustained by radial articular surface to long axis of the radius in PA view - 16° -28° (Average 20°).
B) Radial Length :- It is difference between two perpendicular to the long axis of radius one running from radial styloid process and other touching the lower ulnar surface in PA view (11-12mm).

C) Dorsal / volar tilt :- In lateral view it is an angle between distal articular margin and long axis of radius. A position value when it is volar and negative when it is dorsal.

These radiographic parameters are compared to normal side. The importance of these parameters is for accurate treatment and sufficient radiological follow up after distal radius fracture. Any alteration in radial angle, palmer tilt and radial length cause changes in load distribution between the radius and corpus therefore influence function of wrist. Fernandez (1982) reports that a dorsal tilt of distal radial surface more than 25 degree become symptomatic. The radial shortening is depend on radio carpal alignment. Any deviation of radial length and palmar tilt from normal lead to weak, deformed stiff and painful wrist.

Any malreduction with loss of palmer tilt wrist mechanism, creating an alignment that permits the carpus to collapse dorsally, leads to dorsal midcarpal instability. While malreduction with the loss of angulation towards ulna lead to radial deviation of the head and tend to palmer flex the scaphoid which lead to increase in the scapholunate angle. Shortening of radius with angulation disrupts the congruance of
distal radio-ulna joint. This may cause pain in distal radio ulnar joint (DRUJ).

The conservative treatment was popular for most cases of fractures of distal radius. Today it is the method of choice in most of the stable type of fractures. Fractures of distal end of radius are among the most frequent fracture and are known for malunion even in most skillful hands. In particular, difficulties arise in comminuted, widely displaced, intra-articular impacted fractures and fractures which have redisplaced after satisfactory close manipulative reduction and plaster cast immobilization.

In these fracture the result are consistently poor with the conventional treatment by closed reduction and plaster cast immobilization because although the initial reduction is usually good but it is difficult to maintain. So often redisplacement of fragments occurs inside the plaster cast that shortening of radius and reversion to the original dinner fork deformity after a few days or weeks, is a frequent complication. The problem is related to instability of the fracture due to dorsal comminution or a triangular zone of compression on dorsal and radial aspect leaving behind a bony defect after reduction. The risk redisplacement is still higher after re-reduction (Lidstrom 1959).

Management:

The managment of these fractures consists of the treatment of fractures to physical therapy till the patient gets maximum functional recovery of the affected limb. The treatment has gone into various modifications from the classical method of
closed reduction and immobilization in plaster cast to open reduction and internal fixation in quest to get better result. These methods can be devided as follows:

A. Classical method of closed reduction and immobilization in plaster cast & splint.
B. Pin incorporation in plaster.
C. Open reduction and internal fixation.
D. External fixation
E. Percutaneous pinning.
F. Others.

A) Classical Method:

This has been in clinical use for more than one and half century, still has importance and consists of close reduction of fracture followed by immobilization in plaster cast or splint. The method of reduction has undergone modifications frequently but the basic principles have remained the same.

Method of reduction:

Bassically following three techniques have been used in clinical practice for reduction of such fractures. Complete relaxation of muscle under general anaesthesia & regional block is the pre-requisite for achieving the good reduction.

1- Robert Jones (1915) Method:-

In this method the fracture reduced by traction along the forearm which corrects the impaction using pressure and counter pressure with the help of palm.
2- Bohlers (1923) Method:

In this method impaction is corrected by traction while the wrist in direction of angulation, giving pressure on the distal fragment at the same time.

3- Charnley's Method:

In this method described for colles #, impaction is corrected by traction while angulation are corrected by increasing the deformity, maintaining the traction and pressing the distal fragment in direction opposite to displacement. Finally the fracture is locked in reduced position by pronating the distal fragment and palmer flexion at wrist.

Time of reduction: -

Immediate reduction is considered better than any delay (Frykman 1967). Spongel (1965) recommended immediate reduction in all cases except open fractures or fractures with profound dorsal angulations.

Method of immobilization: -

Dorsal plaster splints advocated by Bohler (1919 & 1923) later - on used by Lidstrom (1959) seems to be most common method of immobilization in Europe (Smail 1965) for colles fractures. Circular plaster cast on forearm is a better method of immobilisation and prevents redisplacement. However an above elbow cast has been recommended by Sheek (1962), and Spongel (1964) but it restricts the shoulder movements. Some
American authors recommend a sugar tong plaster with or without circular plaster bandages (Older,s Stabler and Cossebaum 1965). Frykman (1967) recommended dorsal splint or below elbow cast for stable fractures and advised inclusion of elbow if the fracture was not stable.

Position of immobilisation:

For colles fracture Bohler (1919) advised dorsiflexion and moderate ulnar deviation at wrist and forearm midway between supination and pronation. This was accepted by Frykman (1967). Palmar flexion and ulnar deviation has been recommended by Gartland and Werley (1951), and Frykman (1957) is some cases but Bohler (1919) many years before then strongly condemned fixation is palmar flexion. Nutral position of wrist recommended by Lidstrom (1959) has also been adopted by Frykman (1967) in most of his cases. However position of ulnar deviation which helps in healing of associated injury of ulnar collateral ligament or ulnar styloid process (Hollings worth1975) has been liked by many authors. Mayer (1940) described supination twist as a component of colles fracture and according to Blichest - Toft and Jensen (1971) pronation of forearm corrects this component and gives better results. On the other hand Sarmiento (1965 & 1975) considered brachioradialis pull responsible for redisplacement of fracture and recommended full supination of forearm.

B) Pin incorporation in plaster:

This method advocated first by Bohler (1929) for both comminuted colles fractures and Bartons fracture
dislocation has undergone my modifications, however in each of the techniques the basic underlying principles has been to provide a fixed skeletal traction which prevents shortening of radius and late collapse. Bohler (1929) inserted pins in proximal part of ulna & metacarpal bases. Goodwin (1942) modified the technique by putting only a pin in first metacarpal and gave counter traction with a L-shaped bar fixed to above elbow plaster cast. Dowling (1961) advocated technique of percutaneous pinning of radial styloid to ulna after close reduction for comminuted fracture. He reported satisfactory results but this technique did not get popularity. Marsh and Teal (1972) after using pins at different sites found better results with distal pin in 2-3 metacarpals and proximal pin in ulna and reported better results.

C) Open reduction and Internal fixation:

Rush in 1949 did fixation of colles fracturer with a pin which is now known as rush pin. Later Griffin (1975) used rush pin for comminuted fractures of lower end of radius and reported 92% good to excellent results without significant complications. Pattee (1988) used this method of open reduction and Internal fixation with T-plate or K-wires for Barton's fracture dislocation in some cases but the results were not superior to conservative treatment. Therefore a recommended that this should be used only after an initial trial with conservative method but can be used if there are associated carpal or intercarpal injuries.
Physiotherapy:-

This is an important part in the management of fracture of lower end radius and need regular attendance of the patient and attention of the physiotherapist. Since Bohler (1929) stressed value of active functional training, many authors have indicated desirability of carefully instructing the patients about active finger movements in the beginning of the treatment and strongly emphasizing the value of using hand as much as possible for every day task during period of healing (Gutman 1959), Madsen (1959), Kudelka (1963), Von Trappen (1964), Smail (1965) and Soren (1965). Active movements of shoulder decreases chances of shoulder stiffness and should be continued throughout the period of treatment (Moberg 1955), Guttman (1959), Rehn (1965) Frykman (1967) condemned the use of a sling. The patient soon after the removal of plaster should be started the active exercise of the wrist.

Complications:-

Complications occur in 19% (Cooney 1980) to 80%. (Gartland and Werley 1951). The special problems of colles fracture were the loss of reduction leading to loss of radial length and angles and above all in the problem of secondary osteoasthriotis of radiocarpal or inferior radio ulnar joints.

Redisplacement occurs in 27% to 60% of colles fractures, mainly intra-articular fractures as reported by Gartlant and Werley (1951) and Cooney (1980) respectively. Incidence of secondary osteoasthritis has been reported from 40%
(Gartland & Werley 1951) to as high as 65% as reported by Knirk (1986). He also found that the incidence can be as high as 91% of the joint incongruity is not restored at time of manipulation. The incidence of osteoarthritis is more common in inferior radio ulnar joints and fractures of Frykman types IV to VIII.

The following complications can also occur which are common for all fractures at distal end of radius and depend on method of treatment.

**Complications in conservative method:-**

1. **Finger stiffness:-**

   This occurs usually due to improper plaster cast application (Cooney 1980) and inadequate physiotherapy. Various incidences varying from 7% (Frykman 1967) to 20% (Grahman 1938) have been reported.

2. **Malunion:**

   It is a common problem and occurs because of redisplacement of fracture rather than inadequate reduction. Though dorsal tilt is more common but can be accepted by patients while radial deviation and radial shortening give rise to pain at distal radio ulnar joint and may require resection of head of ulna.

3. **Loss of wrist movements:-**

   Though Graham (1935) and Bacorn (1953) both found that Palmar flexion was the commonest movement to be restricted (48% and 95.5%) respectively, Knirk (1986) in a study on intra-articular fractures found that supination is limited more
commonly then only other movement. Dorsiflexion is the second most common movement to be limited.

4. Loss of grip strength:-

Grip strength has been considered very important by Sarmiento (1975) and others. It can be lost in about 7.5% 24% and 40% Cases as reported by Lidstrom (1959), Frykman (1967) and Sarmiento (1975) respectively.

5. Neurological dysfuctions:

Although transient neuritis of median, ulnar and radial nerves have been seen in about 7.9% cases (Cooney 1980), but median nerve dysfuction occurs more commonly. It can present as early complications immediately after injury due to either median nerve contusion or increased pressure in carpal tunnel (Gelberman 1984; Melone 1984) or late in the course of treatment due to excessive callus, Persistent haematoma, localised swelling or cotton loder's is position. If it occurs immediately after injury then surgical decompression of carpal tunnel should be done urgently while late complications should be managed just like in any other carpal tunnel syndrome.

6. Shoulder stiffness:

This is also a rare complications and occurs in 1 to 4% cases as reported by Bacorn (1953) and Cooney (1950) respectively.
This can be prevented by active exercise of shoulder during course of treatment and not using the cuff and collar by discarding it early.

7. Sudeck’s osteodystrophy:
This problem though rare but difficult to treat when occurs. It occurs in 1 to 12% cases as found by Bacorn (1953) and Frykman (1967). It should be managed by prolonging immobilisation Sympathectomy or Beir’s block using hydrocortisone with anaesthetic agent. If stiffness is in unacceptable position manipulation under general anaesthesia followed by immobilisation in plaster can be tried.

8. Disturbances of distal radio ulnar joint:
Damage to this joint occurs at time of injury and if radial length is not restored the joint remains permanently disrupted and leads to pain on rotatory movements in about 4% intra-articular fractures (Frykman 1967)

9. Tendon rupture:
Rupture of tendon of extensor pollicis longus is a rare complications which occurs in .7% (Frykman 1967) to 1% (Cooney 1980) very rarely ruptures of tendons of flexor pollicis longus and extensor digitorum proprius of index and ring fingers can occurs in fourth week either because of the vascular damage occurring at time of injury or due to attrition of tendon around lister & tubercle. It can be treated either by end to end
suture (Trevor 1945) or transfer of tendon of extensor induces proprius.

10. Nonunion and delayed union:-
Very low incidence of non-union (0.2% and delayed union (.2%) have been reported by Bacorn (1953)

11. Volkmans Ischemia :
It occurs due to tight plaster cast and Cooney (1980) has found this problem in about 1% patients.

D) External fixation:-
Since Anderson Roger and O' Neil (1944) described external fixator as a method of treatment for comminuted fractures of lower end of radius, lot of work has been done on this subject.

Jones (1977) modified the Roger Anderson device which provides means of rigid fixation of comminuted intra-articular fractures and allows active motion of fingers and elbow while maintaining radial length. Cooney (1979) found good results with Roger Anderson fixator. Forgon (1981) used external fixator for unstable colles fractures and found that it effectively prevents redisplacement and maintains the reduction. Cooney (1983) compared results using four different types of fixators and found quadrilateral frame provides better and effective immobilisation. Several types of fixator have been devised among which Roger Andersons frame, Ace-colles fixator, Mini Hoffman fixator
Hoffman C-series fixators are most popular. Foster (1986) treated comminuted intra-articular fracture of lower end of radius with Roger Anderson frame and Hoffman c-series fixator and reported food to excellent results with both techniques. None was found superior to other inspite of rigid configuration of Hoffman c-series fixators.

With external fixator the wrist cannot be mobilised and to overcome this Clyburn (1987) devised a dynamic external fixator which allows movements of wrist while maintaining the radial length. He noted that mobilisation of wrist in flexion alone gives better results than mobilising in both extension and flexion. Foster (1986) recommended use of external fixator in following conditions:-

1. Comminuted intra-articular fractures which cannot be managed by other methods in physiologically younger patients.
2. Comminuted extra articular fractures in which position cannot be maintained in physically younger patients.
3. Fractures associated with soft tissue injuries.
4. Bilateral upper extremity injuries.

E) Percutaneous pinning:

Percutaneous K-wire fixation techniques are an attempt to bridge the therapeutic gap between ext. Fixator and pure casting alone. The K-wire prevent displacement of distal radial fragment by buttressing effect after the fracture reduction. This technique is used in extra articular displaced, intra articular
undisplaced or minimally displaced fracture which can be reduced by ligamentotaxis.

**Ligamentotaxis:**

Ligamentotaxis is the process in which continuous and appropriate pull is exerted through intact ligament around articular juxta articular fracture to restore and maintain the skeletal length, alignments and reduction. The wrist immobilised in natural position in slab after pinning fixation.

Various percutaneous pinning were developed. The first percutaneous pinning technique was evaluated by Lambotte (1980) who used pure radial styloid pinning for distal radial fractures. In this technique 23% rate of secondary fracture displacement was reported by Buzyn (1965).

In 1952 Depalma introduced ulnar radial pinning without fixation of the dispal radial ulnar joint. The K-wire was introduced 4cm above from the ulnar styloid process which passed through the ulna into distal radial styloid.

In 1975 Stein fix the distal radial fracture by radial styloid and dorsal radial pinning. The first K-wire was introduced from radial styloid and other from dorsal ulnar-radial fragment. The wire passed the fracture line and inserted to opposite cortex to prevent secondary displacement.
In 1976 UML described radial styloid and ulnar-radial pinning of the postero medial fragment. This technique was used for fractures associated with dorsal medial fragment of distal radius.

In 1976 Kapandji described intrafocal pinning for distal radial fracture. The 2mm K-wires were introduced into fracture line and then tilted 45° to long axis and fixed to opposite cortex. These pins did not engaged distal fragment by buttressed the distal fragment. Some secondary displacement was reported.

In 1987 Kapandji further evaluated this technique and advised for triple intrafocal percutaneous pinning technique. The third doraolumar pin was also introduced from fracture line in between 1st and 2nd pin. This technique buttressed the distal fragment in place.

In 1989 Rayhack first reported the ulnar radial pinning with fixation of distal radio-ulnar joint. The multiple pins were introduced from ulna to distal radius by a zig. The percutaneous pinning was a effective simple surgical technique for distal radial fractures treatment.

Rayhack in (1989) popularised ulnar radial pinning with fixation of distal radio ulnar joint. The multiple pins are introduced from ulnar side towards radial styloid process to fix the distal radio ulnar joint.
Clancey (1979) introduced the percutaneous technique one K-wire from the radial styloid process just proximal to the radial artery in snuff box at 45° to long axis of radius and 10° dorsally then 2nd K-wire form the ulnar side of radius in between 4th & 5th extensor canal at 45°, 30° ventrally and engaging opposite cortex.

The percutaneous pinning is an attempt of bridge the gap between external fixator and pure casting alone. Percutaneous K-wire fixation provides adequate fixation of distal fragment that invokes minimal interference with the function of adjacent joints, so it is associated with a minimal rate of complications.

The goals of percutaneous pinning are:-

1. The least number of days in a cast or splint during the fracture healing phase.

2. Avoidance of fracture redisplacement.

3. Application of technique to all fractures which can be reduced by ligamentotaxis.


5. Negligible use of x-ray or image intensifier.
Fig 1. Instruments
T-handle
Kirschner wires
Wire nipper
Fig 2. Steps of Operation
- Fresh case of Colles fracture
- Pre-operative photograph

Fig 3. Photograph after manual reduction