FUNCTIONAL OUTCOME OF MONTEGGIA FRACURES TREATED PRIMARILY WITH PLATE FIXATION

A RETROSPECTIVE STUDY OF THE OUTCOME

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ABSTRACT

Fractures of the forearm with dislocation of the radial head are known as Monteggia fractures-dislocation. This eponym is among the most widely recognized by orthopaedic surgeons, largely because of the notoriously poor results associated with the treatment of these injuries, particularly in adults. In addition to restoration of length, apposition and normal axial alignment and correct rotational alignment must also be achieved if a good range of pronation and supination is to be restored.

Monteggia fractures in adult are distinct from those in children with regards to mechanism and patterns of injury, the prognosis, and the preferred method of treatment. A retrospective study was undertaken on 29 patients with acute Monteggia fractures who were treated in Hospital USM, Kubang Kerian, Kelantan for a period of 5 years from July 1996 to March 2000.

It involved 25 closed Monteggia fractures and 5 open Monteggia fractures. The age ranges from 14 years to 50 years with a peak incidence occuring between 21 years to 30 years. The follow-up ranged from 12 to 56 weeks with a mean follow-up of 20.6 weeks.

There were 25 fractures treated with DCP and the remaining 4 fractures were treated with semitubular plate.

The overall union rate was 89.7% and the delayed union rate was 10.3%. There were surprisingly no nonunion in this study group.

The excellent to good functional results based on Grace and Eversman(1980) criteria were obtained in 65.6% of cases.

The majority of the patients in this study who presented with Monteggia fracture dislocations were of the Bado type 1 and of the transverse configuration, and who were

treated with compression plate had a high percentage of satisfactory results. It was found to be statistically significant in this study.

The infection rate was 10.3%. Interestingly there were no cross-union in this series of study

There is no statistically difference between the functional outcome and the different types of Monteggia fractures based on Bado classification.

Abstrak

Kepatahan tulang di lengan serta 'dislocation' radial head adalah satu kecederaan yang mendapat banyak perhatian diantara pakar-pakar otopedik kerana keputusan yang di capai adalah tidak memuaskan terutamanya diantara golongan orang dewasa.

Pengkajian 'retrospective' telah dilakukan keatas 29 pesakit yang mengalami kepatahan tulang Monteggia di lengan yang telah dirawat di Hospital USM, Kubang Kerian, Kelantan daripada bulan July 1996 sehigga bulan March 2000.

29 pesakit telah dirawat secara pembedahan dan distabilkan oleh 'compression plate'. Dari jumlah ini 24 pesakit mengalami kepatahan tulang tanpa luka dan 5 pesakit patah berserta dengan luka.

Mereka semua berada dalam lingkungan umur 14 hingga 50 tahun. Kesemua pesakit telah menerima rawatan susulan dalam tempoh masa 12 hingga 56 minggu degan purata 20.6 minggu.

Pada keseluruhannya, kadar penyembuhan tulang adalah 89.7% dan kadar 'delayed union' adalah 10.3%. Yang menghairankan tiada terdapat 'nonunion'.

Sejumlah 65.6% dikalangan pesakit-pesakit yang dirawat secara pembedahan telah mencapai keputusan 'functional outcome' yang cemerlang dan baik. Didalam pegkajian ini telah didapati kepatahan Monteggia tanpa luka, kepatahan jenis 'simple' dan jenis I mengikut klasifikasi Bado mencapai peratus akhir yang memuaskan.

Didalam siri pengkajian ini, kadar jangkitan kuman adalah sebanyak 10.3% dan tiada terdapat sebarang komplikasi 'cross union'.

Secara perbandingan, tiada terdapat apa-apa perbezaan secara statistik diantara jenis

fundamental action of picking up small object. Full supination was needed for everyday actions as to turn the car key, to switch the engine on, screwing the nuts etc.it was possible to compensate partly for loss of pronation by abducting the humerus, but limitation of supination does not allow compensation by any such maneuver.

Effective treatment of Monteggia fractures in adults is notoriously challenging in the past, as evident by the many poor results published.(Watson Jones). However these were overcame by the wide application of the stable plate-fixation techniques that were developed by the Association for the Study of Internal Fixation(AO/ASIF). This had created interest in the author to look at the outcome of plate fixation in the treatment of Monteggia fractures.

Most author agreed that the recommended fixation of the ulnar fracture with a stout plate, such as a 3.5mm limited-contact dynamic compression plate, applied to the posterior surface of the ulna and if necessary contoured proximally to reach the tip of the olecranon.(Ring, Jupiter et al 1998)

2.0 Anatomical consideration.

The forearm is composed of two bones that is, the radius and ulna which function as a unit but come into contact with each other only at the ends by means a well constrained joint and is connected in the mid-portion by the interosseous membrane.

Because this system is relatively tightly constrained, it is difficult to injure one structure without affecting at least one other part of the system.

Sage (1959) studied the radius and ulna in detail and demonstrated that the intramedullary canal of the ulna is relatively straight, the radius however has four small but consistent curves that gives it the distinct radial bow necessary for crossover in pronation while at the same time prepetuating relative tension in the interosseous membrane in all positions.

The oblique orientation of the interosseous membrane allows it to function as both a restrain of the radius and ulna and also as an energy absorbing and weight transfering structure during axial loading.

The central portion of the interosseous membrane is thickened and measures about 3.5 cm in width. It provides 71% of the longitudinal forearm stiffness after resection of the radial head.(Hotchkiss et al)

Normal range of motion has been described as 71 degree to 75 degree of pronation and 82 degree to 84 degree of supination. With the elbow fixed in one position, the rotation of the forearm describes a simple cone with its axis runing roughly from the center of the radial head of the distal part of the ulna.

The radius and ulna are connected at both ends by two relatively well constrained joints, namely the proximal and distal radioulnar joints.

Kaplan and Spinner studied in great detail the proximal radioulna joint. They noted that the radial head is somewhat oval in shape and the greatest diameter of the head comes into contact with the proximal radioulna joint in full supination.

They believe that the interosseous membrane is most taut in this position.

There are two ligaments which stabilizes this joint, the annular (orbicular) ligaments and the quardate ligament (Denule's)

The annular ligaments which is funnel shaped and allows approximately 1 to 5mm of distal translation and the quadrate ligaments which extends between the lateral side of the proximal end of the ulna just distal to the proximal radioulna joints and attaches to the neck of the radius just distal to the articular margin.

The ligament has an anterior and posterior border with the anterior being denser and stronger.

In full supination, this anterior border becomes taut around the neck of the radius and draws it snugly against the proximal radioulna notch.

While in full pronation the posterior fibres become taut and perform a similar function.

To produce an anterior dislocation of the radial head, the annular ligaments, the quadrate ligament and the proximal third of the interosseous membrane must be divided.

A posterior dislocation of the radial head can occur with an intact annular and quadrate ligaments.

2.1 Movements.

The elbow joint allows two main motions that is the pronation-supination and flexion-extention. It is made up of three joints namely the Ulnohumeral, Radioulna and Radiocapitellar.

2.2 Pronation-supination:

Movements which take place at the radioulnar joint results in supination and pronation. Most activities of daily living involved about 100 degrees of forearm rotation from 50 degrees of pronation to 50 degrees of supination.

In pronation, the radius carrying the hand with it is carried obliquely across the front of the ulna its upper end remaining lateral and its lower end becoming medial to the bone. The movement of the radius around the ulna is like that of the handle of a bucket. The head of the radius pivots in the annular ligament, while the lower end swings around the head of the ulna, being attached to it by the articular disc. The axis of rotation of the radius passes through the center of the head of the radius at the upper end and at the lower end it passes through the head of the ulna at the point of insertion of the articular disc.

Ray et al (1951) showed that the true axis of rotation of the hand on the ulna was not stationary but becomes displaced laterally on pronation and medially in supination. Throughout the arc of rotation, the fibres of the interosseous membrane remain taut even though the bones are separated widely in supination and approximated in pronation. Thus the interosseous membrane is able to transfer any forces from the wrist and hand to the radius on to the ulna in whatever position the forearm may be placed. (Patric 1946)

2.3 Flexion-extension.

The flexion and extension occur across the ulno-humeral joint which is a trochoginglymus joint.(hinge)

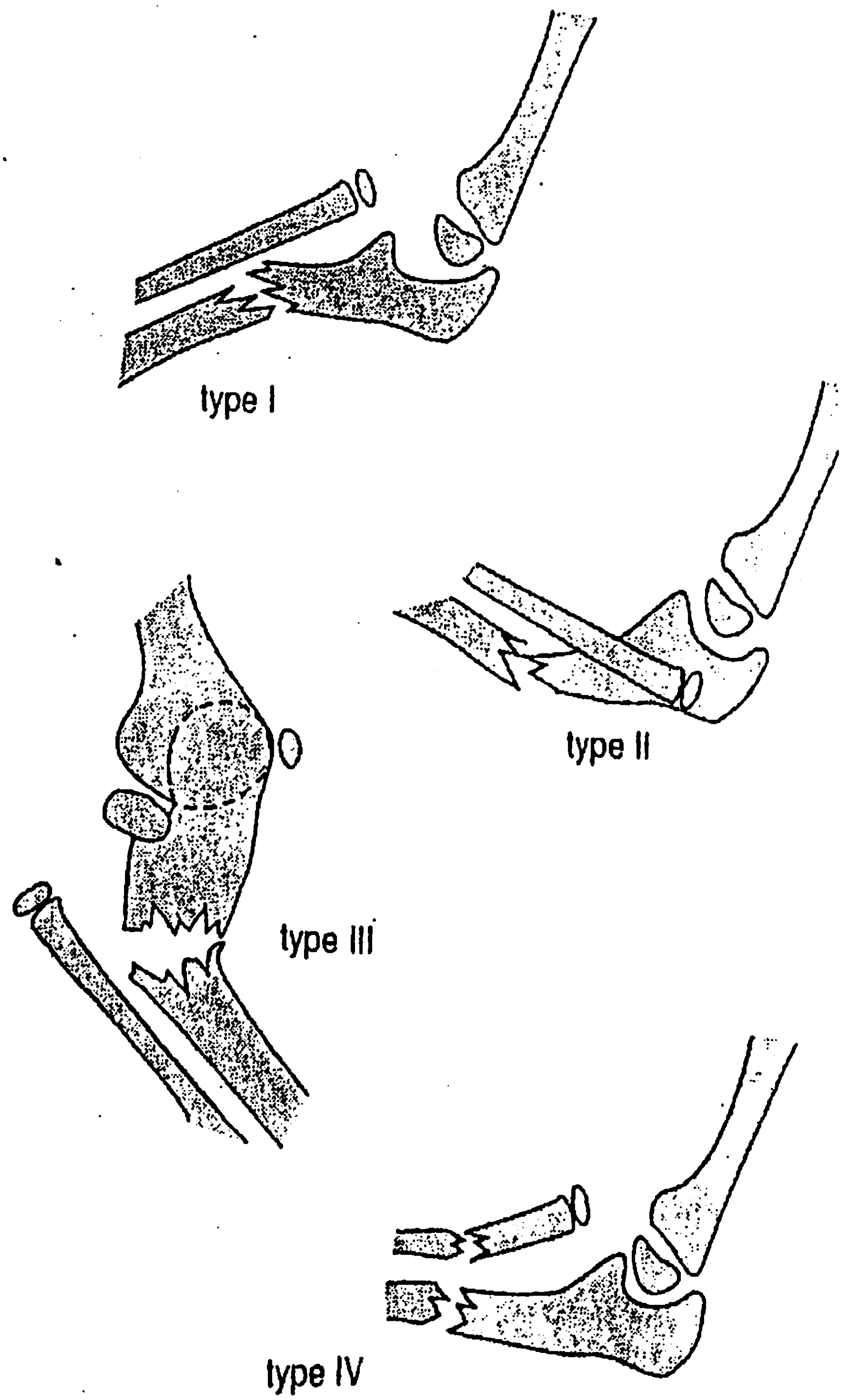
Most activities of daily living involved a functional arc of about 100 degrees from 30 to 130 degrees of flexion.

It is not a purely uniaxial hinge joint through flexion-extension.

Emald (1975) and Ishizuki (1979) found a changing center of rotation of flexion.

Morrey and Chao (1976) noted that slight internal rotation of the ulna occur during early flexion and slight external rotation during terminal flexion.

The Bado classification of Monteggia fracture-dislocation



3.0 Review of literatures.

3.1 Mechanism of injury.

The various types of lesion based on Bado's classification were studied by different investigators and noted to have different mechanisms of injury.

Type 1 lesion:

Evan (1949) postulated that in Type I injuriës the mechanism of injury is forced pronation of the forearm. His reason was that in the majority Type I lesion in his series, there were neither bruising over the subcutaneous border of ulna nor comminution of the fracture that would be expected if it was caused by a direct blow.

He supported his theory with experimental studies where he produced fractures of the ulna with anterior dislocation of the radial head by stabilising a cadaver humerus in a vise and slowly pronating the forearm.

The ulna fractured and as the pronation continued, the radial head was forced anterioly out of the stabilising capsular structures of the elbow.

Type II lesion.

Penrose in 1951 described Type II lesion. He stabilized a cadaver humerus with the elbow flexed and applied a force to the distal radial causing a posterior dislocation of the elbow.

He then weakened the proximal ulna by drilling the bone and again directed a force on the distal radius causing what was later called a Bado type II lesion.

This produced a prosterior angulated fracture of the ulna with comminution anteriorly and a posterior dislocation of the radial head with a marginal fracture of the articular surface of the proximal radius.

Type III lesion.

This was studied by Mullick in 1977, who postulated that the primary force on the elbow was an abduction force. It occurs almost exclusively in children.

If the forearm was pronated the radial head dislocated anterolaterally while if the forearm were supinated, the radial head dislocated posterolaterally.

Type IV lesion.

These lesions were thought by Bado to be type I lesion with an assiociated radial shaft fracture.

3.2 Epidemiology.

Giovanni Battisa Monteggia was the first to describe this injury in 1814 as a fracture of the proximal third of ulna with a dislocation of the radial head.

The injury is uncommon and its reported incidence ranges from 0.4% to 10% in most major fracture dislocation series.

Well over 400 cases have since been reported in the literature.

From the first description, Monteggia fracture dislocation have been problem injuries.

Giovanni Monteggia was one of the few physician to give his name to a condition he misdiagnosed.

Shortly before his death in 1814 he wrote :

" I unhappily remember the case of a girl who seemed to me have sustained a fracture of the upper third of the ulna. At the end of a month of bandaging, the head of the radial head dislocated when I extended the forearm. I applied a new bandage but the head of the radius would not stay in place."

This diagnosis continues to be missed till today. A Monteggia fracture is more common in adult than in children. Adult generally require open reduction and internal fixation, where as children are usually treated by closed reduction.

3.3 Classification.

In 1967, four types of Monteggia fracture dislocation were identified by Bado. He distinguished his defination by calling it a Monteggia 'lesion' rather than a Monteggia fracture as it was named by its originator.

Type I : Fracture of the middle or upper third of the ulna with anterior dislocation of the radial head and characterized by an anterior angulation of the ulna.

Type II : A similar ulna fracture, generally posteriorly angulated with posterior dislocation of the radial head and often a fracture of the radial head.

Type III : A fracture of the ulna just distal to the coronoid process with lateral dislocation of the radial head.

Type IV : Fracture of the upper or middle of the ulna, anterior dislocation of the radial head and fracture of the upper third of the radius below the bicipital tuberosity.

Type V : was added by Domans et al(1990) which involves intermittent and habitual dislocation of the proximal radioulnar and radiocapitellar joints.

A review of the literature surveying 310 Monteggia fractures disclosed that typeI accounts for 65% of cases, type II for 18%, type III for 16% and type IV for 1%.

Bado named additional injuries that he felt were equivalent to type I lesion:

1. An anterior dislocation of the radial head in an adult or child (pulled elbow syndrome)
2. A fracture of the ulna diaphysis with anterior dislocation of the radial head and a fracture of the olecranon.

Bado felt that epiphyseal fractures of the radial head would be involved in a type II equivalent injury. There were no equivalent to the type III and type IV injuries.

3.4 Signs and symptoms.

Swelling about the elbow, deformity and bony crepitus and pain with movement at the site of the fracture. One maybe able to palpatate the radial head. A careful neurological examination is critical because nerve injuries especially the radial nerve are not uncommon with Monteggia lesion.

Boyd and Boals(1969), Bruce(1974), Jessing(1975) all reported acute injuries of the radial nerve or its terminal branches, the posterior interosseous nerve. Most of the nerves injuries are assiocated with type III Monteggia lesion.

Spar (1977) reported on an entrappment of the posterior interosseos nerve preventing close reduction of the radial head. This occurred in a type III lesion where the head had been dislocated anterolaterally.

Engher (1982) reported on anterior interosseous nerve palsy following a type I lesion. Ulnar nerves had been reported to be involved in associated with Monteggia lesions, but they are less frequent.

A tardy radial nerve palsy have reported in a patient seen with a malunion of a Monteggia fracture. (Austin 1976)

3.5 Radiographic finding.

A true anteroposterior and lateral radiographs of the elbow must be included in any upper extremity injury that involves a displaced fracture of the ulna. A true lateral view of the elbow can be obtained if both the humerus and forearm lie flat on the x-ray cassette. With both the humerus and forearm lying flat on the cassette in near 90 degrees of flexion, a true lateral film of the elbow can be obtained regardless of the position of the forearm.

McLaughlin (1959) noted that in order to ensure proper aligment of the radiocapitellar joint, a line drawn down the shaft of radius through the radial head should bisect the capitellum of the position of the forearm.

3.6 Treatment.

Historically, the treatment of this injuries, especially of the dislocation of the radial head has been controversial.

Bohler (1956) stated that all Monteggia fracture dislocation could be treated non operatively. Speed and Boyd (1940) surveyed the result of 52 of these injuries treated before 1940 and found that the best result were obtained when open reduction of the radial head with repair or reconstruction of the annular ligament was carried out internal fixation of the ulna.

Boyd and Boals (1969) published a report on a series of 159 Monteggia type injuries with recommendation for rigid internal fixation of the fractured ulna with either a compression plate or a medullary nail and reduction of the radial head. Most of the dislocated radial head in this series could be reduced by manipulation, and almost 80% of their result were excellent to good when acute injuries were so treated.

Open reduction of the radial head or reconstruction of the annular are reserved for those instances when satisfactory closed reduction is not achieved.

The experience gained all the while, now suggest that this combination of fracture of the ulna with dislocation of the proximal end of the radius with or without fracture of the radius usually can be treated conservatively in children but routinely requires open reduction in adults.

3.6.1 Closed method of treatment.

Closed reduction of the fracture ulna fragments and dislocated radial head with immobilization in cast is the treatment of choice in children.

Piero and Andres (1977) in a series of 25 Monteggia lesions in children, in most cases of type I lesions, noted that reduction was easily accomplished with gentle longitudinal traction of the arm in extension with the arm kept in supination and occasionally the need for anterior pressure on the radial head to reduced it. The elbow is then flexed at a right angle to maintain reduction.

If closed reduction cannot be maintained, the ulna reduction needs to be reevaluated, it should be noted that the oblique ulna fracture is frequently a more unstable pattern.

If the radial head is reducible but grossly unstable after anatomic ulna reduction, the radial head may be transfixed across the capitellum or to the proximal end of the ulna. However complications such as pin migration, pin breakage or proximal radioulnar synostoses have all been described.

A type II Monteggia lesion is reduced by applying traction to the forearm in full supination.The radial head is reduced by direct pressure, and the posterior angulation of the ulna fracture is anatomically aligned with direct pressure.

This fracture is prone to re-angulate with the elbow flexed and this lead to redislocation. For this reason, Peiro and Andres (1977) and Dormans and Rang (1990) recommened casting the arm in full extension.While others believe that all Monteggia fractures can be immobilized in flexion.

In type III lesion, reduction can be accomplished by longitudinal traction, followed by a valgus stress on the extended and supinated elbow . Application of the direct pressure over the lateraly displaced radial head against the proximal radioulnar notch, and then correction of the valgus and flexion.

After reduction, a long plaster splint is applied with the elbow immobilized in 80 - 90 degrees of flexion and the forearm in supination until the fracture shows radiological evidence of healing.

The importance of immobilization of the forearm in fully supinated position has been emphasized by Spinner (1970), as it is the most stable position for the proximal radioulnar joint. It is in this position , that the broadest joint surface contact exists between the proximal ends of the radius and ulna, the interosseous membrane is taut, and the quadrate ligaments tightens and pulls the radius tightly up against the ulna.

3.6.2 Open reduction and Internal Fixation.

The results reported with closed reduction of these injuries in adults have not been as successful as in children.(Charnley 1974, Dodge 1972, Smith and Sage 1957, Boyd 1940).

This is probably due to the fact that the annular ligament usually remains intact in children where as it must be ruptured in adults for anterior dislocation to occur. Also it is because of the relatively close tolerance of the forearm articulation, the radial head will remain in a subluxed position unless the ulna is anatomicaly reduced.

Tile (1987) therefore recommenced fixing the ulna by using the techniques and implants of the ASIF group and then using and image intensifier to examine the stability of the radial head in all positions.

If the radial head is grossly unstable or cannot be reduced, the ulna reduction should first be reevaluated, and then a direct operative approach as described by Boyd (1940) should be made to the radial head, if necessary, to remove any soft tissue interposition.

Most recent authors including Anderson (1975), Boyd (1961), Reckling (1968), and Bruce (1974) recommenced open reduction and compression plate fixation of ulna and close reduction of the radial head dislocation.

Smith and Sage (1957) produced good results after medullary fixation of forearm fractures, but most authors today believe that compression fixation devices provides a more rigid constructs than intermedullary fixation of the ulna.

Anderson noted that for good results in Monteggia fractures depend on the following:

1. Early accurate diagnosis.
2. Rigid fixation of the ulna
3. Accurate reduction of the radial head.
4. Post operative immobilization to allow ligamentous healing about the dislocated radial head.

According to Richards and Corley (1996) whose experience with 40 Monteggia fractures, they have found that a 3.5mm dynamic compression plate and a 3.5mm pelvic reconstruction plate are equally suitable implants for stabilization of the fracture ulna.

3.6.3 Timing of surgery.

Monteggia fractures should be treated as an urgent problem. If possible, close reduction of the dislocation is accomplished in the emergency department and early operative intervention is advocated. Open reduction should be addressed as an emergency.

3.6.4 Approach and reduction.

After the extremity have been adequately sterile prepped and draped, a closed reduction of the radial head is performed using distal traction and direct pressure over the radial head.

It is believed that this maneuver may lessen the likelihood of damage to the posterior interosseous nerve during the subsequent open reduction of the ulna.(Fred G. Corley, Rockwood and Green's Fractures in Adults, 4^{th} Edition 1996).

After the reduction of the radial head, skin incision is made over the posterior aspect of the forearm, and a straight surgical approach is made to the ulna. However I normally fixed the fractured ulnar first, as the radial head will eventually get reduced by itself after the ulnar is stabilized.

The fracture site is exposed by subperiostealy dissecting around the fracture lines so that key fragments can be used in reducing the ulna to its appropriate length.

Care must be taken to avoid any injuries to the dorsal sensory branch of the ulna nerve if the incision extends distally over the ulna shaft.

Only the area where the plate is to be placed should be stripped of periosteum to ensure adequate blood supply to the ulna shaft.

Some authors (Reckling 1968, Bruce 1974) prefer to place the plate on the base subcutenous surface of the ulna for two reasons:

1. In the proximal fractures, mobilization of the ulna nerve is avoided when the plate is placed on the extensor surface.
2. If the radial head needs to be explored, it is easy to continue the incision along the extensor surface proximally over the elbow joint and expose the radial head by reflecting the supinator.

After the ulna has been reduced, a 3.5mm dynamic compression plate is placed on the ulna with bone clamps, stabilizing the reduction.

The radial head reduction is confirmed on image intensifier as well as the reduction of the ulna. If the x-ray show accurate reduction, the plate is applied with the appropriate 3.5mm screws after stabilization of the ulna, the elbow is passively ranged to acess the stability of the radial head.

The fascia is not closed. The skin and subcutaneous tissues are closed, and a drained is left deep in the wound.A long posterior splint is applied to the forearm in neutral position.

3.6.5 Post operative care:

The dressing and splint are removed at 5 to 7th day and replaced with a long arm cast or brace, depending on the assessment at the time of surgery. If the patient is reliable and the fracture was stable trhrough a full range of motion at the time of surgery, after 7 to 10 days the patient is allowed to remove the posterior splint and do active flexion and extension, pronation and supination excercises of the elbow, supervised initially by a therapist.

If there is some question about the fracture site stability or stability of the radial head, a long arm cast is recommended for 6 weeks before motion is allowed.

X-rays are taken at 2 weeks, 4 weeks and 6 weeks.

After 6 weeks, if fixation is adequate and there is evidence of early healing at fracture site, all external support and protection is discontinued.

3.7 Over view on the evolution of compression plate fixation.

According to Mears (1972) plating of fractures is traceable into the last century, when Hasman described a percutaneously removable plate in 1886.

Later on, Lane, Lambotte and Sherman developed implants and techiques of plate osteosynthesis in 1935.

Pauwels defined tension band technique in 1935.

Danis (1949) pioneered techniques of compression osteosynthesis and defined primary union biologically.

In 1950, Peterson defined basic principles of bone plating:

- Careful handling of implants.
- Proper orientation of the screw head in the plate.
- Measurement of screw holes with a depth gauge.
- Final tightening of all screws.
- Drill diameter slightly smaller than screw diameter.
- Correct plate contouring before application.

Compression plating is meant to achieve rigid fixation of the fracture. Rigid fixation promotes primary bone healing, in which contact healing occurs. The apposed bone ends heal by cutting cones of revascularization that cross the fracture site. In such healing, periosteal callus is scant or absent. The appearance of external callus, sometimes referred to as irritation callus may be evidence of motion or infection.

In the 1960s, there was a surge in knowledge with regards to biology of bone healing and the biomechanics of bone healing in an internally fixed fracture, and this has led to development of more superior implants and surgical techniques which had led to an improvement in overall care of fractures.

Edgers in 1940s, belived that contact compression was important in healing of cortical bone when he hypothesized that end resorption between even firmly fixed fragments leads to radiographically visible gap at the fractured site, with subsequent non union.

Danis (1949) was the first person to design a plate that would provide compression at the fracture site. He noted that well fixed fracture with axial compression healed with little callus. Initially many surgeons were doubtful if compression at the fracture site would cause bone necrosis. This had stimulated further investigations into the natural process of bone healing. Ham (1930) subsequently showed that the ends of the broken bones are actually dead for a variable distance. Many author subsequently showed that stable fixation with compression actually prevented the resorption of the fracture ends by allowing direct remodelling of the bone ends across the fracture site with minimal formation callus, the so called primary bone healing. (Schenk and Willeneger 1967)

Perren (1969) contributed much to the understanding of the biomechanics of fracture healing in fractures fixed with implants. He studied in depth with regards to the concepts of stability of fixation, the importance of compression on stability of fixation especially with regards to plate fixation.

He experimentally proved that instability induces bone resorption thereby compromising primary bone healing.

Experimental studies by Danis (1949), Muller and associates (1965) showed that fractures treated with compression plate healed with primary intention and that periosteal new bone formation played a small role.

Anderson (1965) observed that with rigid fixation by compression plate, union occurred in the medullary canal without going through enchondral phase, however it was a slow process. (McKibbin 1978)

With this concept, a stronger plate to improve the rigidity of fixation and with the similar compression features as the plate designed by Danis was developed by Muller et al (1965) and it became the prototype of the modern ASIF compression plate.

Thus in 1960s and early 1970s, the dynamic compression plate (DCP) was developed to overcome some of the disadvantages of the round plates which needed compression effect.

With the use of compression plates, the AO group of surgeons in Switzerland reported success using the ASIF compression plate in the treatment of forearm fractures in the early 1960s.

It was not until the early 1970s that the results of the use of the ASIF plates began to appear in the English literature.

Naiman (1970) reported that 100% of 30 plated forearm fracture bones united.

Dodge and Cady (1972), in a series of 78 patients reported non union rate of 6.4%.

Anderson et al (1975), in a study of 224 patients noted a union rate of 97.3%.

They attributed their success to the adherence to the principles of compression plates in achieving uninterrupted healing through medullary callus and possibly primary bone healing.

In 1980, Grace and Eversman stress of the importance of the treatment of forearm fractures with rigid internal fixation and early motion. He stressed that besides acheiving union of the fracture, which was one of the main goals, achieving satisfactory motion should also be an important goal, if not more in the management of upper limb injury. In their study of 112 patients, they showed that a program of early motion helped retain significantly more range of forearm motion in patients who had fracture of a single or both the forearm bones as compared to patient who had post operative immobilization in a cast.

Despite the success enjoyed by this compression plating, there were numberous series of publication with unsatisfactory results, such as by Dodge and Cady (1972), Fisher and Hamblen (1980), Stern and William (1982).

Dodge and Cady reported significant complications like loss of fixation (5%), post operative sepsis (13%), non union and delayed union (13%) and refracture (1%).

Stern and Williams (1983) reported an alarming rate of complications in the series of 64 patients with non union in 6%, loss of fixation in 3.4%, radioulnar synostosis in 11%.

All these authors attributed most of there complications to technical errors resulting from the lack of understanding of principals of compression plate fixation and familiarity to the AO instrumentations.

In the begining of the 1980s, the AO dynamic compression plate had became increasingly popular and the were encouraging results which were published by various authors utilizing this device and ASIF principles.

Grace and Eversman (1980) and Hadden et al (1980) achieved non-union rate of 3% and 4% respectively, infection rate of 3% and 5% respectively and overall satisfactory functional results of 80%.

Chapman et al (1980) published the best ever result of compression plate fixation of forearm fracture with a non union rate of 1.5%, infection rate of 2.3% and satisfactory results of 91%, of which 83% had an excellent results.

3.7.1 Management of open Monteggia fracture dislocation.

With more broad spectrum antibiotics and improvement in fracture fixation techniques, there is a changing trend toward immediate open reduction and internal fixation of open fractures especially in the management of the multiple injured patients and open intra-articular fractures. (Chapman 1980, Anderson and Gustillo 1980)

Studies have shown that besides an acceptable rate of infection, among open fracture, which had immediate internal fixation, some achieved excellent functional results. (Ritman et al 1979)

This indication of immediate internal fixation of open fractures had extended into the management of forearm fractures.

Studies have shown that the upper extremities appear to have less risks in accquring infection when internally fixed as compared to lower extremity. (Moed et al 1984, Chapman and Mahoney 1978)

Chapman (1980) attributed this to the fact that upper limb had better circulation, soft tissue coverage and the trauma was usually of low energy type.

Moed et al (1984) in his specific study of the forearm fracture, reported infection rate of only 4% and non union rate of 8%. Over all satisfactory results in 85% of the patients who had immediate internal fixation of open fracture of forearm bones despite almost half the patients had grade II and grade III open fractures.

Chapman et al (1984) in a retrospective study of compression plate fixation of forearm fracture, reported only one case deep infection among 49 cases (2%) of open fractures with immediate open reduction and compression plate fixation.

3.7.2 Treatment of neglected Monteggia fracture dislocation.

For injuries six weeks or older in an adult, the Boyd approach is used, and the fracture of the ulnar is rigidly fixed internally and the radial head is excised. Usually autogenous iliac bone graft are placed about the fracture.

A posterior plaster splint is applied with the forearm in neutral position and the elbow in 90 degrees of flexion.

The splint can be discarded after 4 to 5 days, provided the fixation is rigid and the wound is healing satisfactorily. The arm is then supported in a sling. Gentle active range range of motion exercises of the elbow and pronation and supination are permitted. The fracture is usually solidly united by 8 to 10 weeks.

Excision of the radial head is contradicted in children. The treatment of Monteggia fracture dislocation 6 weeks or older in children, is by osteotomy of the ulnar and reconstruction of the annular ligament and if necessary the radiocapitellar articulation held with a pin inserted across the radial head and neck into the capitellum.

Technically, this is an exacting procedure, and the result have not been always been satisfactory.

The dangers of the transcapitellar pin are well known, such as the possibility of pin tract infection or breakage of the pin.

Historically , a chronic untreated isolated radial head dislocation or after Monteggia fractures with chronic persistent radial head dislocation, it had been ignored until skeletal maturity. At that time , if necessary, the radial head is resected.

Resection of the radial head in a child leads to angular deformity at both the elbow and the wrist.

If the dislocation is symptomatic, it should be resected only at skeletal maturity. In 15 older children in whom the radial head was resected, Speed and Boyd noted abnormalities in only 3 patients.

In these 3 patients , approximately 1 cm of radial shortening was seen at the level of the radial styloid.

The distal ulnar was somewhat prominent and the hand was slightly deviated towards the radius.

According to reports in the literatures, the radial head can be reduced satisfactorily as late as 6 months or even longer after traumatic dislocation. This generally requires an osteotomy of the angulated ulnar followed by open reduction of the radial head, reconstruction of the annular ligaments with fascia or other soft tissue and stabilization of the radial head in normal position against the capitellum.

Bell-Tawse (1965), Lloyd-Roberts (1977) had all described satisfactory results.