Dissertation

on

DESCRIPTIVE ANALYSIS OF CLAVICLE HOOK PLATE FOR FRACTURES OF THE LATERAL END OF CLAVICLE & ACROMIOCLAVICULAR JOINT DISRUPTION

A dissertation submitted to the Tamil Nadu Dr. M.G.R. Medical University in partial fulfillment of the requirement for the award of M.S. Branch II (Orthopedic surgery) degree March 2009 – 2011.

CERTIFICATE

This is to certify that this dissertation

"DESCRIPTIVE ANALYSIS OF CLAVICLE HOOK PLATE FOR THE FRACTURES OF THE LATERAL END OF CLAVICLE AND ACROMIOCLAVICULAR JOINT DISRUPTIONS"

is an original work of research done by Dr. Khanapur Ronald Immanuel

towards partial fulfillment of the requirements for the award of

MASTER OF SURGERY (Branch II, Orthopedic surgery) Degree.

Signature of the Guide

Dr. Samuel Chittaranjan

M.S. Orthopedics

Professor & Head,

Department of Orthopedics unit – III

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Signature of the H.O.D

Dr. Vernon .N. Lee

D.Orth., M.S. Orth., M.Ch(L'pool)

Professor & Head,

Department of Orthopedics.

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INDEX

1 INTRODUCTION

Fractures of the lateral end of the clavicle account for 15% of all clavicle fracture (1) while 9% of shoulder girdle injuries involve damage to the acromioclavicular joint (2). These fractures have been associated with disruption of the coracoclavicular ligaments and are unstable because of four displacing forces that retard union. The nonunion rate is approximately 30%, sometimes causing pain and impaired function of the shoulder girdle and upper limb and hence surgery is recommended for unstable distal clavicular fractures (3). Over the years a variety of surgical treatment options have been developed with varying success. Currently clavicle hook plate is accepted as a surgical option for these injuries and in a country like India, price many a time dictates implant choice. This study is 2 pronged- intended to analyze the results of our clavicle hook plate which has been indigenously customized at this centre as compared with the literature and also to assess the need for repair of the soft tissue structures around the acromioclavicular joint which according to us may not be necessary. We will be analyzing the results based on clinical outcomes and radiological assessment so as to ascertain the efficacy of this procedure coupled with indigenously made implant.

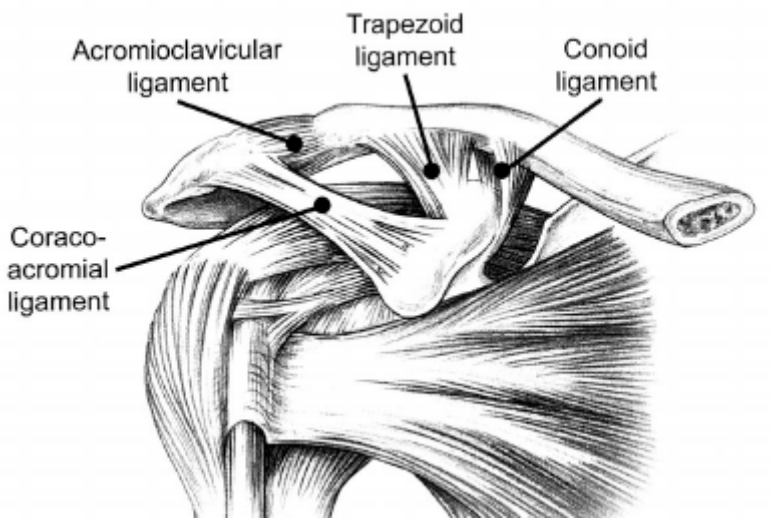
2 AIMS AND OBJECTIVES:

The aim of this study is to analyze:

1. The outcome of hook plate fixation for the fracture of the lateral end of clavicle and acromioclavicular joint disruptions operated in our hospital.
2. To assess the need for repair of the acromioclavicular capsule, ligaments and coracoclavicular ligaments at all.
3. To assess the reduction and stability of the AC joint.
4. To identify the complications related with this implant.
5. To assess the need and indication for implant removal.
6. To assess the time taken to reach pre-injury functional status.

3 ANATOMY

The acromioclavicular joint (AC joint) provides a ‘keystone’ link between the scapula and the clavicle. The coupling of scapulothoracic and glenohumeral movement dictates that the integrity of the sternoclavicular and acromioclavicular joints is important for the normal co-ordination of movement of the shoulder girdle.



Ligamentous anatomy of the acromioclavicular joint complex (4)

Acromioclavicular joint (AC) which is approximately 9 mm by 19 mm (4), is a diarthrodial joint with a fibro-cartilaginous meniscal disk that separates the articular surfaces of the acromial process and the distal clavicle (2). Together with the sternoclavicular joint, the AC joint provides the upper extremity with a connection to the axial skeleton.

The capsule surrounding the joint is reinforced by the AC ligaments comprising of superior, inferior, anterior, and posterior ligaments. The superior and inferior ligaments are stronger than the anterior and posterior ligaments.

Vertical stability of the clavicle is provided by the coracoclavicular (CC) ligaments, which are composed of the conoid and trapezoid and superior and inferior AC ligaments. A bursa may separate these two portions of the ligaments. The trapezoid ligament measures 0.8 to 2.5 cm in length and 0.8 to 2.5 cm in width. The conoid ligament is 0.7 to 2.5 cm in length and 0.4 to 0.95 cm in width.

The distance from the lateral clavicle to the lateral-most fibers of the trapezoid ligament measures as little as 10 mm

The AC ligaments are the principle restraint to anteroposterior translation (offers 90% anteroposterior and 77% superior translation stability) between the clavicle and the acromion while AC and CC ligaments together form the static stabilizers of the AC joint:

- The horizontal stability is controlled by the AC ligament.
- The vertical stability is controlled by the coracoclavicular ligaments.

Distraction of the AC joint is limited by the AC ligaments (91%) and compression by trapezoid ligament (75%).

The dynamic stabilizers are the deltoid muscles (attached to spine and acromion) and trapezius (attached to the lateral third of clavicle, spine of scapula and acromion). The fibers of the superior AC ligament blend with the fibers of the deltoid and trapezius muscles, which are attached to the superior aspect of the clavicle and the acromion process. These muscle attachments

are important in strengthening the AC ligaments and adding stability to the AC joint.

Viewed anteriorly, the inclination of the joint may be almost vertical or downward medially, the clavicle overriding the acromion by an angle of as much as 50°.

Because of the small area of the AC joint and the high compressive loads transmitted from the humerus to the chest by muscles such as the pectoralis major, the stresses on the AC joint can be very high.

Urist (5) in his study demonstrated that by excision of AC joint capsule, the distal clavicle could be completely dislocated anteriorly and posteriorly away from the acromion process however, the vertical displacement of the clavicle relative to the acromion occurred only after the coracoclavicular ligament was transected thereby concluding that the these ligaments may not be the main restrainers to the dislocation of AC joint.

4 REVIEW OF LITERATURE

Hippocrates wrote:

"Physicians are particularly liable to be deceived in this accident (for as the separated bone protrudes, the top of the shoulder appears low and hollow), so that they may prepare as if for dislocation of the shoulder; for I have known many physicians otherwise not expert at the art who have done much mischief by attempting to reduce shoulders, thus supposing it as a case of dislocation".

Galen obviously had paid close attention to Hippocrates, because he diagnosed his own AC dislocation received from wrestling in the palaestra. This famous physician of the Greco-Roman period treated himself in the manner of Hippocrates (i.e., tight bandages to hold the projecting clavicle down while keeping the arm elevated). He abandoned the treatment after only a few days because it was so uncomfortable. It is appropriate that one of the earliest reported cases in the literature was related to sports, because today participation in sports is certainly one of the most common causes of AC dislocations (6).

From the earliest publications through the time of Paul of Aegina (7th century), dislocations of the AC joint have become better recognized. Their treatment, however, has remained essentially unchanged. Hippocrates stated that no impediment, small or great, will result from such an injury. He further stated that there would be a "tumefaction" or deformity, for the bone cannot be properly restored to its natural situation. This statement apparently was, has been, and will be received by the orthopedic community as a challenge. There is probably not another joint in the

body that has been treated in so many different ways as the AC joint in attempts to "properly restore it to its natural situation".

4.1 **ACROMIOCLAVICULAR JOINT INJURIES**

4.1.1 BIOMECHANICS OF THE ACROMIOCLAVICULAR JOINT

The coupling of scapulothoracic and glenohumeral movement dictates that the integrity of the sternoclavicular and acromioclavicular joints is important for the normal co-ordination of movement of the shoulder girdle. Until recently, movement at the acromioclavicular joint had not been accurately defined and was perhaps underestimated (7).It is now appreciated that during abduction of the shoulder, there is 15° of protraction, 21° of upward rotation and 22° of posterior tilting of the scapula relative to the clavicle at the joint.

Lanz and Wachsmuth (8) describe 3 directions of motion for the acromioclavicular joint: the lower angle of the scapula moves in the frontal direction around a sagittal axis, and in the sagittal direction around a frontal axis. The scapula can turn in the acromioclavicular joint around a longitudinal axis up to 50º. The lower angle of the scapula can swing around the longitudinal axis of the clavicle to reach a total of 60º, *2/3*rd of this motion being in the acromioclavicular joint.

Kapandji (8) describes a 30º axial rotation in the acromioclavicular joint and reaches the same value by adding 30º rotatory mobility in the sternoclavicular joint. According to **Fischer et al** (8) considered the acromioclavicular joint as a relatively loose joint.

Codman described the AC joint with the scapula as synchronous scapula clavicular rotation The CC ligaments are responsible for the upward rotation of the clavicle and downward rotation of the scapula, during abduction and forward elevation(6).

4.1.2 MECHANISM OF INJURY

Direct force is the most common mechanism of injury and is produced by the patient falling onto the lateral aspect of the shoulder with the arm in an adducted position. The force drives the acromion downward and medially (6). The downward displacement of the distal clavicle is primarily resisted through an interlocking of the sternoclavicular ligaments. If no fracture occurs, the force first sprains the AC ligaments (a mild sprain), then tears the AC ligaments (a moderate sprain) and stresses the coracoclavicular ligament, and finally if the downward force continues tears the deltoid and trapezius muscle attachments from the clavicle and ruptures the coracoclavicular ligaments (a severe AC sprain), which completes the dislocation. At this point, the upper extremity has lost its suspensory support from the clavicle and droops downward.

The mechanism for the inferior dislocation of the clavicle under the coracoid is thought to be a very severe direct force onto the superior surface of the distal clavicle, along with abduction of the arm and retraction of the scapula. This type of AC joint dislocation is exceedingly rare

In children though, the acromioclavicular joint lacks inherent structural stability. It is held together in part by the acromioclavicular ligaments, which are relatively weak secondary stabilizers. The primary stabilizers of the joint are the two

coracoclavicular ligaments, the conoid and the trapezoid. The distal clavicle and the acromion are surrounded by thick periosteum that forms a protective tube around the bony structures to which the coracoclavicular ligaments are attached on the inferior surface of the distal clavicle. Because these ligament attachments are stronger than the periosteum, displacement of the distal clavicle occurs through a disruption in the periosteum rather than by detachment of the ligaments.

4.1.3 INCIDENCE

Acromioclavicular (AC) joint injuries account for approximately 9% of shoulder girdle (2). Most occur commonly in active young athletic adults in their second through fourth decades of life. Contact sportspersons like in rugby, hockey players have a higher incidence as there were more frequent injuries to the shoulder joint. Forwards were more vulnerable than backs- 65% of Forwards and 25% of backs had sustained injuries to the acromioclavicular joint. Males are more commonly affected than females, with a male-to-female ratio of approximately 5:1(9). Rowe and Marble retrospectively reviewed the medical records of the Massachusetts General Hospital and found 52 AC joint injuries among 1,603 shoulder-girdle injuries (10). Most occurred in the second decade of life. Thorndike and Quigley reported AC joint involvement in 223 of 578 athletes with shoulder injuries.

4.1.4 INDICATIONS FOR SURGERY

Rockwood I is a sprain and hence is stable, not requiring surgery

Rockwood II is a rupture of the AC ligament and sprain of CC ligament. The joint retains

some of its stability and hence non-operative management has been recommended (2).

Rockwood type I and II - Analgesic medication and nonsteroidal anti-inflammatory drugs are used to relieve pain. Cryotherapy helps reduce swelling and pain. A sling is worn for comfort. As the pain and swelling subside, early active and passive motion and physiotherapy are recommended (2).

Gladstone and colleagues (11) described a four-phase rehabilitation program:

Phase 1, pain control and immediate protected range of motion and isometric exercises;

Phase2, strengthening exercises using isotonic contractions and proprioceptive neuromuscular facilitation exercises;

Phase 3, unrestricted functional participation with the goal of increasing strength, power, endurance, and neuromuscular control;

Phase 4, return to activity with sport-specific functional drills.

Most patients are able to return to normal activity in 2 to 4 weeks.

An athlete is ready to return to competitive sports once the following criteria are met:

1. Full range of motion, no pain or tenderness,
2. Satisfactory clinical examination, and
3. Demonstration of adequate strength on isokinetic testing

Most athletes are able to return to play in 2 to 4 weeks but other authors reported that some require up to 12 weeks (2)

There is a lack of consensus regarding the indications for surgical intervention, a wide variety of implants and suture materials and more than 50 operative procedures

and numerous modifications have been reported for treating these injuries with variable success rate(9).

Rockwood III-VI

Throughout recorded medical history, both nonoperative and operative methods of treatment of complete AC dislocation have enjoyed intervals of popularity as it is considered a transitory type (relatively stable) of injury between a stable (type I and II) and unstable (type IV-VI).

Sage and Salvatore (12) analyzed 96 injuries to AC joint.

31 patients were treated nonoperatively with adhesives, casts and strappings for an average period of 3.4 weeks. They noticed that 36%had AC joint in its normal position, 50% were subluxed with some dislocations. The results were excellent in 70.8%, good in 12.5% and poor in 16.7%

30 patients were treated with AC joint transfixation alone using wires or pins which were maintained for an average of 9 weeks. This group had 67.7% excellent results, 22.6% good results and 9.7% poor results.

16 patients were treated with temporary pins inserted across the AC joint, CC ligament were repaired with heavy silk, capsule repaired with catgut and sometimes they used the meniscus to reinforce the superior AC ligament and did repair of the AC ligament whenever possible. The duration to pin removal averaged 9 weeks. 62.5% had excellent, 31.25% had good results and one patient had poor result.

Goss (5) defined the concept of the superior shoulder suspensory complex. It is a ring made up of bony superior glenoid, the coracoid process, the distal clavicle,

the acromion and soft tissue component of acromioclavicular joint and its ligaments, the coracoclavicular ligaments.

It is likened to the pelvic ring wherein damage to one part of the superior shoulder suspensory complex must also produce disruption of another portion of the osteoligamentous ring, leading to the so-called ‘double disruptions

Therefore all type-III to type-VI dislocations fall within this category, since both the acromioclavicular and coracoclavicular ligaments are injured. Dislocations which occur together with fracture of another component of the complex such as the lateral clavicle or coracoid process are also double disruptions.

These types of injuries are unstable and may result in adverse long term effects of healing and function.

He suggested that these injuries should be considered for operative reduction and stabilization of at least one component of the disruption.

Urist (13) in 1946 reviewed 101 previous papers and reported between 10% and 20% unsatisfactory results following conservative management. These unsatisfactory results were attributed to the position of the joint. Interestingly, he had noted variations in the normal anatomy in his evaluation of 100 shoulders.

1. The articular surface of the clavicle overrides the articular surface of the acromion. 49

2. The articular surfaces of acromion and clavicle are nearly vertical and lie in the same plane 27

3. The inferior margin of the articular surface of the clavicle under-rides the superior margin of the acromion 3

4. The articular surfaces are incongruent, and the clavicle overlies the acromion 9

5. The articular surfaces are incongruent and are not in contact at any point 6

6. The articular surfaces are incongruent, and inferior margin of the clavicle under-rides the superior margin of time acromion**.** 6

Bannister (14) in the1983 he treated 60 patients with AC disruptions, 33 nonoperatively and 27 he operated on and found that at 4 months the nonoperated group did better but at the end of 1 year both faired equal and at 4 years operated group did betted. 4 patients initially treated nonoperative, required surgery and around 15% of the patients treated conservatively were reported to have poor results. Of the operated group two had screw cut out, 1 had screw breakage, and 2 had to be re-operated for painful subluxation.

4.1.5 NON OPERATIVE TREATMENT

Numerous methods of nonoperative treatment have been advocated and with varied result (11).

AUTHORS	FORM OF TREATMENT
Thorndike and Quigley	Adhesive strapping
Benson Rawlings Jones Watson-Jones Hawkins	Sling &Bandage
Anderson & Burgess	Brace &Harness

Giannestras	
Usadel	Figure of Eight bandage
Goldberg	Sling & pressure bandage
Caldwell	Abduction traction &suspension in bed
Urist	Casts
Strubbins &McGaw	
Dillehunt	
Gibbens	

4.1.6 OPERATIVE TREATMENT

Earliest reports of AC joint repair were attributed to **Samuel Cooper** in the year 1861 by using a silver wire (15).

In the late 19th century, he was followed by **Poirier, Rieffel, Tuffier, Baum** who used sutures to repair the AC ligaments and the joint capsule (15).

Paci in the year 1889 advocated arthrodesis of the AC joint. **Budinger** used a screw while **Lambotte and Delbet** used a nail for AC joint fixation (15).

Morestin was the first to resect out the lateral 2.5 cms of the clavicle (5).

Delbet is credited for the first attempts of reconstructing CC ligaments initially using a silver wire and later a silk suture (15).

Cadenat (10) is attributed to the usage of a strip of tendon of short head biceps to reconstruct the CC ligaments but later found anterior displacement of clavicle due to its anterior transposition. In 1917, he was reported to have used the coracoacromial ligament to reconstruct the CC ligament because of the insertion

of the coracoacromial attachment onto the coracoid (it being more posterior than biceps tendon and near the origin of CC ligament) and secondly to the fact that harvesting anterior part of this ligament sufficed in length for the repair.

Bunnel in 1928 used a fascia lata to reconstruct the AC joint (5).

Henry (15) in 1929 used autogenous fascia lata with addition of 2 Kirschner wires.

In the decade between 1930 -1940 there was a resurgence of nonoperative treatment modalities for the then Tossy type III.

The surgical options began to develop with growing interest in this type due to the growing conflict of non operative treatment.

Murray recommended smooth Kirschner wires while **Bloom** recommended two 1/32-inch Steinman pins (5)

Excision of the distal 1/3 of clavicle was described by **Mumford and Gurd** in 1941 but the earliest literature suggests **Morestin** as the first person to do this procedure as early as the late 19th century.

Bosworth (2) in 1941was the first to describe a screw inserted from the clavicle into the coracoid and thereby functioning similar to the CC ligament.

Phemister in 1942 reported the use of heavy threaded pins across the AC joint (5).

Stewart described the usage of a screw to fix the AC joint

Caldwell in his 1943 paper, stated that he preferred arthrodesis of the AC joint as a treatment option (16).

Weaver-Dunn in 1972 reported their results of transfer of coracoacromial ligament to lateral end of clavicle after excision of the lateral end of clavicle (17)

In 1964, **Bailey** presented the transfer of coracoid process with the conjoined tendon to the clavicle.

In 1965, **Dewar and Barrington** presented their modified version of Bailey procedure (18).

Balser(in the mid 1980s) presented a new concept on the uses of a hook plate and later **Wolter** (late 1980s) presented his modification of the hook plate(19).

4.1.6A INTRA-ARTICULAR ACROMIOCLAVICULAR REPAIRS

Many authors have described a variety of surgical modalities as mentioned above and though they have had good results, they were also some disadvantages associated with them.

While most authors initially began with Kirschner wires alone but later surgeons combined its usage with soft tissue procedures as a mainstay for the treatment.

Lizaur et al (20) in a prospective study of 46 patients used 2 Kirschner wires and proceeded with repair of the damaged deltoid and trapezius fascial insertion. The wires were inserted from the lateral edge of the clavicle and left protruded through the skin for removal at a later date. 10.9% had re-displacement along with other complications like infection, wire migration.

Larsen et al (21) in a random controlled trial of 87 patients being treated either nonoperatively or by a modified Phemister procedure. They noted a high incidence of implant breakage, migration and failure of fixation in 21 patients apart from erosion of bone, skin irritation and infection by metal in 6 patients and

hence recommended against the use of smooth wires. All but 2 had maintained reduction with Kirschner wires.

The authors concluded that most patients could be treated nonoperatively with a shorter rehabilitation time.

Thirteen patients in the **Sage and Salvatore** study (12) had a Mumford procedure done on them and found excellent in 69.2%, 15.4 with good results and 7.7% with poor results.

Bateman (12) attempted reconstruction of CC ligament by creating a new suspensory ligament out of fascia lata. Intra-operatively, if the AC joint was found degenerative then, excision of the lateral end of clavicle was advised.

Neviaser (12) detached the coracoacromial ligament from the coracoid and swung it on top of the distal end of clavicle thereby reconstructing a new superior AC ligament. He did not believe that the CC ligament needed to be repaired and has shown results

4.1.6B EXTRA-ARTICULAR CORACOCLAVICULAR REPAIRS

They can be divided into:

1. Coracoclavicular ligament repair, fixation or reconstruction
2. Dynamic muscle transfers

3. Excision of the lateral end of clavicle

CORACOCLAVICULAR LIGAMENT REPAIR AND RECONSTRUCTION

In 1917, **Cadenat** (10) transferred the coracoacromial ligament from its coracoid attachment and inserted it to the conoid insertion, the periosteum at the posterosuperior part of clavicle and finally onto the aponeurosis of the trapezius attachment.

Campos (10) had his modification consisting of disinserting the acromial end and transfixing it through a hole in the lateral end of clavicle.

Harrison and Sisler used a Dacron tube circling coracoid and a hole in the clavicle.

Phemister did an open reduction and internal fixation of the AC joint using a 2 ply stainless steel wire which ran from the acromion to the lateral end of clavicle (10).

Bundens and Cook added to Phemister procedure by imbricating the deltoid and trapezius muscles over the clavicle to help stabilize the clavicle.

Weinstein et al (22) used a No.5 non absorbable suture as their modification of Phemister to avoid the wire break out seen with Phemister procedure.

Tauber M et al and **Gonzalez** et al have developed the use of autogenous semitendinosis and peroneus brevis grafts respectively(23).At present gracilis tendon, toe extensors are also being used.

Chen et al used Marsilene prosthetic substitute to reconstruct the CC ligament

Dacron or velour Dacron graft has been used by many surgeons like **Goldberg, Kappakas, Tagliabue and Riva, Dahl** and they have found good results especially with double velour Dacron graft (15).

Polydioxanone (5) graft has been described for successfully usage by **Hawkins et al, Krueger-Franke M et al, Morrison DS, Lemos MJ et al, Nicholas SJ et al.**

Wellmann et al (24) have used 2 flip buttons to anchor the lateral end of clavicle to coracoid. In their study they used 12 fresh frozen cadaveric shoulders, the AC ligament and CC ligaments reconstructions were tested. They initially severed the coracoacromial ligament off the acromion and then inserted it into the lateral end of clavicle and further reinforced with two No.5 Ethibond suture and tested its stability. For the augmentation, 1mm Ethibond is intertwined between 2 flip buttons, one button is passed through a predrilled hole into the base of coracoid and another button into the clavicle at a distance of 35mm from AC joint. Then he medial half of coracoclavicular ligament is released and inserted into a predrilled clavicle at 20mm from the AC joint. The results showed that an augmented CAL transfer can restore the intact acromioclavicular joint kinematics whereas the selective coracoclavicular ligament transfer cannot.

Lee evaluated the biomechanical properties of the CC ligament repair, Weaver-Dunn procedure, combinations using autogenous tendons and synthetic tapes and sutures in cadavers. He found that simple CC ligament repair was weak and had the worst failure load (25).

Tienen combined the open Weaver-Dunn procedure with AC ligament repair with PDS and showed good results (26)

LaFosse did a modified Weaver-Dunn procedure arthroscopically using fire-wire braids initially stitched thorough the substance of CA ligament and then proceeded to disinsert it by burring and finally attaching it to the clavicle thorough a predrilled hole and securing it with metal wires. The results were comparable to the open procedure but with less incidence of infection, keloids and implant failure (26)

CORACOCLAVICULAR FIXATION:

Bosworth described his technique of coracoclavicular fixation in the year 1941 by using a tapered lag screw with a large flat head which he passed into the coracoid from clavicle superiorly. He did not explore nor repair the CC ligament (10).

Kennedy and Cameron in 1954 modified Bosworth procedure by doing a thorough debridement of AC joint, over correcting the AC joint dislocation with a Bosworth lag screw and finally repair the deltoid and trapezius tear. They believed that the screw will produce an ossification of the CC ligament and thereby create an extra-articular arthrodesis of AC joint. Weitzman had a similar modification of Bosworth as by Kennedy and Cameron but differed by debriding the AC joint and imbricating the deltoid and trapezius (27).

Jay and Monnet added to the Weitzman modification by repairing the CC ligament.

Tsou inserted a cannulated cancellous screw percutenously has associated complication rates (28).

Tanner and Hardegger used a 6.5-mm screw (29).

Bateman in a prospective study of 60 patients randomly treated operatively (Bosworth method) and nonoperatively. In the nonoperative group 4 patients failed to respond to this method of treatment and underwent surgery for weakness and pain while 45 of the operated patients developed loss of reduction and hardware failure. They thus concluded that non operative treated was superior (30).

Bancha Chernchujit (28) et al operated 32 patients with AC joint disruptions arthroscopicaly using anchor suture to create a synthetic CC ligament. They had no wound complications, free mobility was seen in 12 patients and cosmetic scars were seen in all patients. 10 patients revealed anatomical reduction, 2 patients had a small (2-4mm) loss of reduction and one with complete dislocation. Patient satisfaction was 92% and Constant score averaged 95.

DYNAMIC MUSCLE TRANSFERS:

Bailey in 1964 was the first to do a transfer of the coracoid process with the conjoined tendons and showed favorable results (15).

Later in 1965, **Dewar and Barrington** did an addition to the Bailey procedure by using a segment of the detached pectoralis minor tendon (18).

Baumgarten et al., Lafosse L et al and Vargas L et al. have studied the use of conjoined tendon to the superior aspect of clavicle as a ‘dynamic muscle transfer’.

They also described modifications to the same by osteotomizing the coracoid insertion with the tendon. They have found this method of conjoined tendon graft transfer has better properties and greater consistency of quality of the graft as compared with those of the coracoacromial ligament. Variations of this procedure, by splitting the lateral half of the conjoined tendon as a distal based, thereby retaining the original coracoid attachment (15).

EXCISION OF THE LATERAL END OF CLAVICLE:

Mumford and Gurd in the year 1941 independently described a surgical procedure for chronic symptomatic subluxed or dislocated AC joints with arthritic changes. They resected the clavicle lateral to the CC ligaments and Mumford repaired the CC ligament.(30)

Weaver and Dunn in 1972 added to the Mumford and Gurd procedure by transferring the coracoacromial ligament to the intramedullary canal of the clavicle (tendon transfer alone was done by Cadenat in 1917) (17).

Powers and Bach compared 47 patients with Tossy III type of injuries comprising of 28 nonoperative (20 treated with a body arm cast and 8 in a sling) and 19 operated (14 had AC joint fixation with wires, 4 with excision of the lateral end of clavicle and 1 with fascial repair of ligament). Out of the 28 not operated only 4 had fair results and the rest were good. Among the operated 9 had good results, 2 fair results and 3 poor results from which they concluded that nonoperative patients had a better result (31).

Various authors have modified this procedure coracoclavicular fixation with heavy nonabsorbable suture, surgical tape, screw, Double-Button with PDS suture material (6), tendon grafts.

This procedure though done open initially is now also done arthroscopically (26).

HOOK PLATE

The earliest descriptive use of hook plate for AC joint disruption would be by Balser in the early 1970s. Wolter D published in the journal of Operative Orthopedic and Traumatology in the year 1989 and he was followed by Ramadazade, Keifer (Sterli hook plate), AC hook plate by Best Medical Company, Tokyo and Dreithaler in 2001(19) .

The commercial hook plate available in India is marketed by AO Synthes™ and is priced between Rs 22,000/- to 25,000/- inclusive of screws.

Ernst Sim(8) in 1995 used the Wolter hook plate in 21 patients. They use a longitudinal incision crossing the clavicle for the approach to the AC joint and lateral end of clavicle. They reconstructed the capsule and ligaments along with stabilizing with the hook plate. They had to shorten or bend the hook depending on intraoperative anatomic findings. No prophylactic antibiotics were given and joint immobilized with a Gilchrist or modified bandage. Physiotherapy was initiated after short period of restricted mobilization. Out of the 21 patients, 6 had

infections and delayed wound healing, 1 had bending of implant, secondary widening of the hook hole in 13 patients, 1 had resorption of the acromial part of clavicle. Cosmetically satisfactory scars were seen in only 3 patients, massive ossification and synostosis in 1 patient, minor arthritic changes in 5 patients.

The AO (synthes) hook plate is a side specific, precontoured plate (32). It comes in 2 variations-

1. "Clavicle hook plate" in 2 specific heights of 15mm and 18mm on 6 or 8 holes plate made of commercially pure titanium or 316L stainless steel. The posterior offset of the hook is to avoid entry into the AC joint and is seated behind the AC joint. This offset is unlike Balser or Wolter plate where the hook was seated into the AC joint. All the studies approached the AC joint through a shoulder strap incision (along the langer lines) and consisted of repair of the ligaments.
2. "LCP clavicle hook plate"- side specific, comes as 4, 5, 6, 7 (combiholes) holes, has 3 hook depths of 12mm, 15mm, 18mm and comes in stainless steel and titanium and priced Rs 22,000/-.

A number of articles support the use of a hook plate (9; 33-35)

D. Sunderamoorthy et al studied the use of a hook plate for AC joint disruption and fracture of the lateral end of clavicle. Of the 14 patients, 5 were painful nonunions and displaced fractures while the rest were AC joint disruptions. Shoulder strap approach, repair of ligaments (Weaver-Dunn) followed by plate fixation, was the surgical procedure done for 9 patients. The mean follow up was 7.2 months.

Functional assessment was done by DASH score and they had a mean score of 12 indicating that this procedure is safe and effective (36).

Alison J McConnell did a cadaveric study comparing 3 fixation constructs- CC sling (5mm Mersilene tape), CC screw (6.5mm partially threaded Bosworth screw) and hook plate (AO synthes hook plate). She found that the CC screw was the most rigid followed by hook plate and then the sling. The CC screw had the highest load to failure and showed greatest amount of stiffness (more than physiological) while the hook plate was near physiological and replicates the stiffness of the AC joint and also allows for physiological movement without pathological deformation.(37)

4.2 **FRACTURE OF THE LATERAL END OF CLAVICLE**

4**.2.1 BIOMECHANISM OF FRACTURE OF THE LATERAL OF CLAVICLE**

The mechanism of injury commonly involves a lateral impaction force on the point of the shoulder. Undisplaced fractures typically occur after trivial injuries, such as a simple fall, whereas displaced fractures often involve more significant trauma, such as a fall from a height, a motor vehicle accident, or a violent blow (38). Displacements are secondary to four displacing forces (6)

1. the weight of the arm
2. the pull of the pectoralis major, pectoralis minor, and latissimus dorsi
3. scapular rotation, which affects the distal segment but not the proximal

4. the trapezius muscle, which draws the medial segment posterior and superior

4.2.2 INCIDENCE

Fractures of the lateral one third of the clavicle are relatively rare, however, and account for only 10% to 20**%** of all clavicle fracture(3) while another study showed a higher incidence of 21% to 28% with the first and largest peak incidence is in males less than 30 years of age.(39)

Neer reported a 10% incidence of associated head and neck injuries in patients with distal clavicle fractures. Other findings may include coracoid and first rib fractures and lung, brachial plexus, and subclavian vein injuries(15).

4.2.3 TREATMENT OPTIONS

The surgical indications for Neer type II are:

EARLY:

1. Double disruption of the shoulder suspensory complex
2. Fracture in a young active person
3. Athlete
4. Manual laborer

LATE:

1. Symptomatic nonunion
2. Symptomatic malunion
3. AC joint arthritis

The natural course of fracture lateral end of clavicle was studied by Anders **Nordqvist** from 1970-79 during which time 336 patients were seen and they were reviewed 110 patients after a period of 15 years (40). What he analyzed was:

Neer Type I had a rapid healing with favorable outcome though some had malunion, nonunion and excessive bone formation.11% had persistent symptoms

Neer Type II had 22% nonunion and on long term follow up 8 out of 10 were painless nonunions due to fibrotic tissue interposition. They did not exhibit deformity or instability.

The treatment options for the fractures of the lateral end of clavicle are varied and some have been given up in course of time- ranging from Kirschner wire fixation, excision of the lateral end of clavicle, stabilizing the clavicle onto the coracoid by a screw, Dacron graft slings, bone grafting (41)

Kasif Khan L.A. et al in their recent review article affirmed nonoperative treatment in Neer type I and operative intervention in Neer type II and III.(42)

They went on to add that Kirschner wire technique by Neer was to be discontinued due to its high complication rates (43-46). The use of 2 endobuttons, Transarticular PDS banding, Dacron graft, Coraco-Clavicular sling have been successfully described.

Rokito et al retrospectively analyzed operative (coracoclavicular stabilization) vs nonoperative (sling immobilization) in Neer type II with14 and16 patients

respectively.(47) The UCLA and Constant scores of both groups were similar, but nonoperated group had higher percentage of excellent results. Pain and range of motion scores were similar in both the groups as was the strength and satisfaction. The major difference was the 44% nonunion in the nonoperated group and some were symptomatic.

Kyle E Swanson described a minimal invasive surgery wherein they stabilized the proximal fragment with the help of a Nitinol wire and an oblong button.(48) The wire was passed through a predrilled hole in the proximal fragment and coracoid process and fastened with the help of oblong buttons under the coracoid and on the clavicle while a similar procedure was done by **Nicolas Pujol et al.**(49) In both these reports patient had a good outcome based on the American shoulder and elbow surgeons index (ASES).

C.M.Robinson et al prospectively studied the results of 2 endobuttons fixation for displaced fracture of lateral of clavicle in 14 patients over the age of 60 years.(50) They used a shoulder strap incision and through predrilled holes through the coracoid and clavicle (medial to the fracture) and created a 6 ply sliding pulley effect. They assessed the results based on DASH and SF-36 questionnaire, Constant score and also on radiological findings.

They had no post operative complications, the mean DASH and Constant score continued to improve till 1 year when they had score of 87.1 for Constant and 3.3 for DASH. The advantage of this surgery is in retaining the

implants and avoiding another surgery. In this study they have not mentioned whether they have repaired the ligaments during the surgery.

George Macheras et al treated 15 patients with unstable lateral end fractures with a coracoclavicular screw and repair of CC ligament with No.1 Dacron suture. All the patients had good outcome with bony union at a mean of 7 weeks and a mean of 97 points with ASES shoulder score.(51)

Prasad V.K. Meda in a prospective study using hook plate in 31 patients (21 Neer type II and 10 Neer type III) / 23 acute and 8 delayed presentations. The incision was along the line of the clavicle and fracture site was open reduced. The thickness of the acromion was measured with a depth gauge and appropriate Synthes hook plate used. The CC ligament was repaired with vicryl sutures and fracture site bone grafted. The followed the patients for an average of 40 months and during which time ASES and VAS scoring were done. 6 patients developed impingement, 5 had osteolysis at the tip of the hook. Implant removal was done between 12-16 weeks in all but 6 patients who were asymptomatic and refused the procedure.(3)

Tapio Flinkkilä compared the results of Kirschner wire fixation with hook plate in 39 patients (22 Kirschner wire and 17 hook plates) and found 12 cases of migration, 3 infections, 7 pin migrations, 2 nonunion as compared to 1 fracture of clavicle and 2 nonunion.(52) The same author in another study (53)on the result of hook plate in unstable fractures in 63 patients found 59 unions, 1delayed union, 3 nonunion, 1 infection, 1 frozen shoulder, 3 cases of late

fracture medial to the plate. The mean Oxford score was 15 and Constant score was 32.

A.D.Tambe et al retrospectively assessed the outcome of clavicle hook plating in 18 patients with Neer type II injury after an average follow up of 25 months. All incisions were sabre shaped over the lateral end of clavicle, they initially transfixed with Kirschner wires followed by fixation with Synthes clavicle hook plate. They noticed nonunions in 2, deep infections requiring plate removal in one, fracture proximal to the plate in one and asymptomatic osteolysis was seen in 5 patients. Plate removal was done in 17 patients at an average duration of 5 months. Using a Constant score on 15 of 18 patients, they scored an averaged 88.5 on the affected side as compared to 100 on the unaffected side. (54)

The average pain in the shoulder at rest was 1 (range 0–4), and the average pain on abduction was 2.2 (range 0–5). Patients were asked to grade their shoulder; three said it was back to normal, 11 said it was nearly normal and one said it was abnormal.

Masafumi Kashii et al retrospectively reviewed 34 patients with unstable fracture lateral of clavicle treated by AC hook plate manufactured by Best Medical Company, Tokyo. It was made from a 3.5mm plate (malleable to contour to the clavicle) with 3.5mm screws proximal to the fracture and 2.7mm mini screw for the distal fragment with hook arising in the centre offset, having a depth of 8mm, 10mm and 12mm and hook length of 10 mm was inserted into the AC joint. (19)Ligament repair if done was

not mentioned. Functional assessment was based on Japanese Orthopedics Association (JOA) score. All plates were electively removed after bony union.
The mean JOA was 98.3, good pain parameter (29.5/30) and radiological bony union at a mean of 4.1 months. The mean period between surgery and plate removal was 5.3 months
The complication noticed were plate displacement in one (revised with a standard hook plate), acromion fracture at the hook with cut-out in one, widening of the hook hole in 19 patients and upward migration into acromion in 13 patients. Rotator cuff tear was seen in one patient.

DASH and Quick DASH questionnaires

DASH questionnaire was introduced by the American Academy of orthopedic surgeons as an outcome measure for upper limb disorders.(55) It consists of 30 questions pertaining to shoulder, arm and hand and the severity of each symptom amounting to a total of 100 points, with a scale of 0 (no disability) to 100 (very severe disability). The reliability was measured by the Cronbach alpha coefficient, which was above 0.9 indicating good internal consistency. Therefore, DASH shows small and large changes in disability and 10 point difference of score is of minimal significance.

Quick DASH based on the Spearman-Brown prophesy- the cross-sectional reliability of a questionnaire will be reduced by shortening the questionnaire, given fairly consistent inter-item correlations- the authors reduced the question to 11 yet still

retaining the alpha of 0.90. They created 2 datasets for field-testing and cohort. 3 item-reduction techniques were used, tested and the result was a 11item questionnaire with a Cronbach alpha coefficient of ≥0.92 and an intraclass correlation coefficient of ≥0.94 suggesting that Quick DASH was a more efficient version of DASH.(56; 57)

Constant Score was first described by Constant and Murley in 1986 has a maximum score of 100 points (35%subjective and 65% objective components) and has been widely used in the European countries since 1992.(58-60)

Veronica B. Conboy et al analyzed this scoring system and found that the inter-observer standard deviation, calculated as 8.86, gives 95% confidence limits that a single observer measuring a single subject will be within 17.7 points of the true score.(61) They also noticed that the measurement of power varied with age and sex which was likewise noted by **Leonid Katolik et al**.

In another study by **D. McClelland et al** regarding the application of Constant score for power in elderly patients, they found that age, handedness and occupation bore significant difference in the final score inspite good scores in the remainder of the categories. He further suggested that Constant score be done excluding the power measurements and have a total score of 75.(58)

5 RADIOLOGICAL ASSESSMENT

An x-ray of the affected shoulder does give information of both AC joint disruption and fracture of the lateral end of clavicle. A standing x ray of both shoulders, in a single large film, would demonstrate a clearer picture of AC joint disruptions than supine, because of the weight of the arm revealing the true displacement. Axillary view of the shoulder is also necessary in regard to the AC joint disruptions especially for the Rockwood's type 3 and 6 variety which are displaced posteriorly and subacromial / subcoracoid respectively.

Zanca view (developed to address the superimposition of the AC joint on the scapular spine) is a 10- to 15-degree cephalic tilt view to project an unobscured image of the joint. This view is now routinely used in the evaluation of AC joint injuries and is particularly useful when there is suspicion of a small fracture or loose body on routine views (2; 6)

Stryker Notch view for an associated variant of an AC joint injury involves a fracture of the coracoid process

Stressed radiographic view

Zanca stress view with a 5 kg weight of both shoulder joints simultaneously are taken to evaluate more accurately the integrity of the ligamentous structures by showing the degree of displacement of the acromion relative to the clavicle and also to assess the stability of the AC joint ligaments post healing.(6)

6 CLASSIFICATION

6.1 ACROMIOCLAVICULAR JOINT DISRUPTIONS

Tossy, Mead and Sigmon in the year 1963 described three types of acromioclavicular dislocation (62):

- Stage I- the AC ligament is stretched or partially ruptured and no gross deformity is visible on radiographs.
- Stage II- the AC ligament is ruptured, the coracoclavicular ligament is elongated and on stress radiographs, the AC joint is displaced less half of the AC joint depth.
- Stage III- A rupture of the AC and coracoclavicular ligament is present and standard radiographs the AC joint is displaced over one half of the AC joint depth

This classification was further modified by **Melvin Post** initially in the year 1985 where he proposed what is similar to Rockwood and Young (10)

ROCKWOOD CLASSIFICATION:

Type I - Sprain of the acromioclavicular (AC) ligament.

AC joint tenderness, minimal pain with arm motion, no pain in coracoclavicular interspaces. No abnormality on radiographs.

Type II - AC ligament tear with joint disruption and sprained coracoclavicular ligaments.

Distal clavicle is slightly superior to acromion and mobile to palpation; tenderness is found in the coracoclavicular space.

Radiographs demonstrate slight elevation of the distal end of the clavicle and AC joint widening. Stress films show the coracoclavicular ligaments are sprained but integrity is maintained.

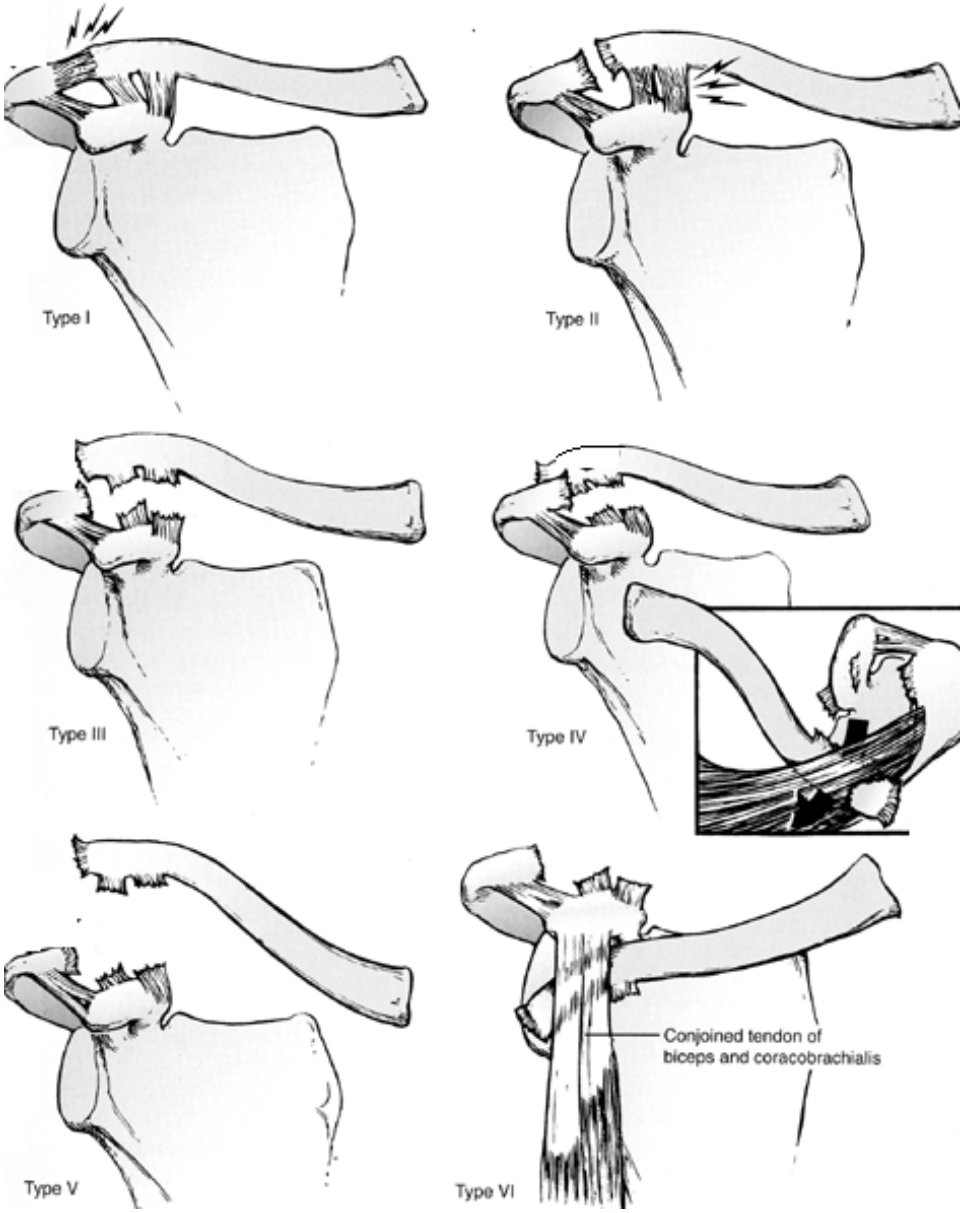


FIGURE**: Rockwood classification of acromioclavicular disruptions**

Type III - AC and coracoclavicular ligaments torn with AC joint dislocation.

Deltoid and trapezius muscles usually detached from the distal clavicle. The upper extremity and distal fragment are depressed, and the distal end of the proximal fragment may tent the skin. The AC joint is tender, coracoclavicular widening is evident.

Radiographs demonstrate the distal clavicle superior to the medial border of the acromion; stress views reveal a widened coracoclavicular interspace 25% to 100% greater than the normal side.

Type IV - Posterior dislocation of the distal end of the clavicle, into or through the trapezius muscle

Clinically, more pain exists than in type III; the distal clavicle is displaced posteriorly away from the clavicle.

Axillary radiograph or computed tomography demonstrates posterior displacement of the distal clavicle.

Type V- A markedly severe version of the type III injury

The distal clavicle is stripped of all its soft-tissue attachments and lies subcutaneously near the base of the neck superiorly.

This type is typically associated with tenting of the skin.

Radiographs demonstrate the coracoclavicular interspace to be 100% to 300% greater than the normal side.

Type VI - Inferior dislocation of the distal clavicle

AC dislocated, with the clavicle displaced inferior to the acromion or the coracoid; the coracoclavicular interspace is decreased compared with normal. The deltoid and trapezius muscles are detached from the distal clavicle.

The mechanism of injury is usually a severe direct force onto the superior surface of the distal clavicle, with abduction of the arm and scapula retraction.

Clinically, the shoulder has a flat appearance with a prominent acromion; associated clavicle and upper rib fractures and brachial plexus injuries are due to high energy trauma.

Radiographs demonstrate one of two types of inferior dislocation: subacromial or subcoracoid.

Patte's classification:

Grade	**Denomination**	**Coracoclavicular distance**	**Facet deviation**	**Rockwood type**
I	Simple sprain	Normal	Non	I
II	Acromioclavicular dislocation	Normal	Subluxation	II
III	Scapuloclavicular dislocation	> 50% increase	Subluxation/dislocation	III
IV	Irreducible scapuloclavicular dislocation	> 50% increase	Mainly posterior	IV
V			Mainly superior	V
VI	Inferior dislocation	Negative		VI

The pediatric Rockwood classification:

- Type I - Clavicle stable; joint radiographically normal
- Type II - Partial tear of the periosteal tube, allowing for some mobility of the distal clavicle; AC ligament disrupted
- Types III-VI - Larger tear through the periosteal tube, allowing for greater clavicle mobility and gross instability with clavicle positioning; CC ligament remains attached to the clavicle periosteal tube

6.2 FRACTURES OF THE LATERAL END OF CLAVICLE

Allman proposed a classification based solely on the anatomic location of the fracture (63), and divided clavicle fractures into:

1**.** Middle third

2. Distal (lateral) to coracoclavicular ligaments

3. Proximal (medial) third

This system does not describe displacement, comminution, or shortening, all potentially important prognostic and treatment variables[4].

Neer (15) recognized the unique behavior of distal clavicle fractures and proposed a separate classification system. He proposed 3 types

Type I: coracoclavicular ligaments intact

Type II: coracoclavicular ligaments detached from the medial segment but trapezoid intact to distal segment

Type III: intra-articular extension into the acromioclavicular joint

Rockwood (15) further subdivided type II into

Type-IIA Injuries the ligaments remains intact

Type-IIB Injuries the coracoclavicular ligaments are partially or completely detached.

Craig (15) further modified the Neer and Allman systems by the inclusion of the additional subdivisions of medial and lateral-end fractures

Type I - minimal displacement (interligamentous)

Type II - displaced secondary to fracture line medial to the coracoclavicular ligaments

(A) conoid and trapezoid attached

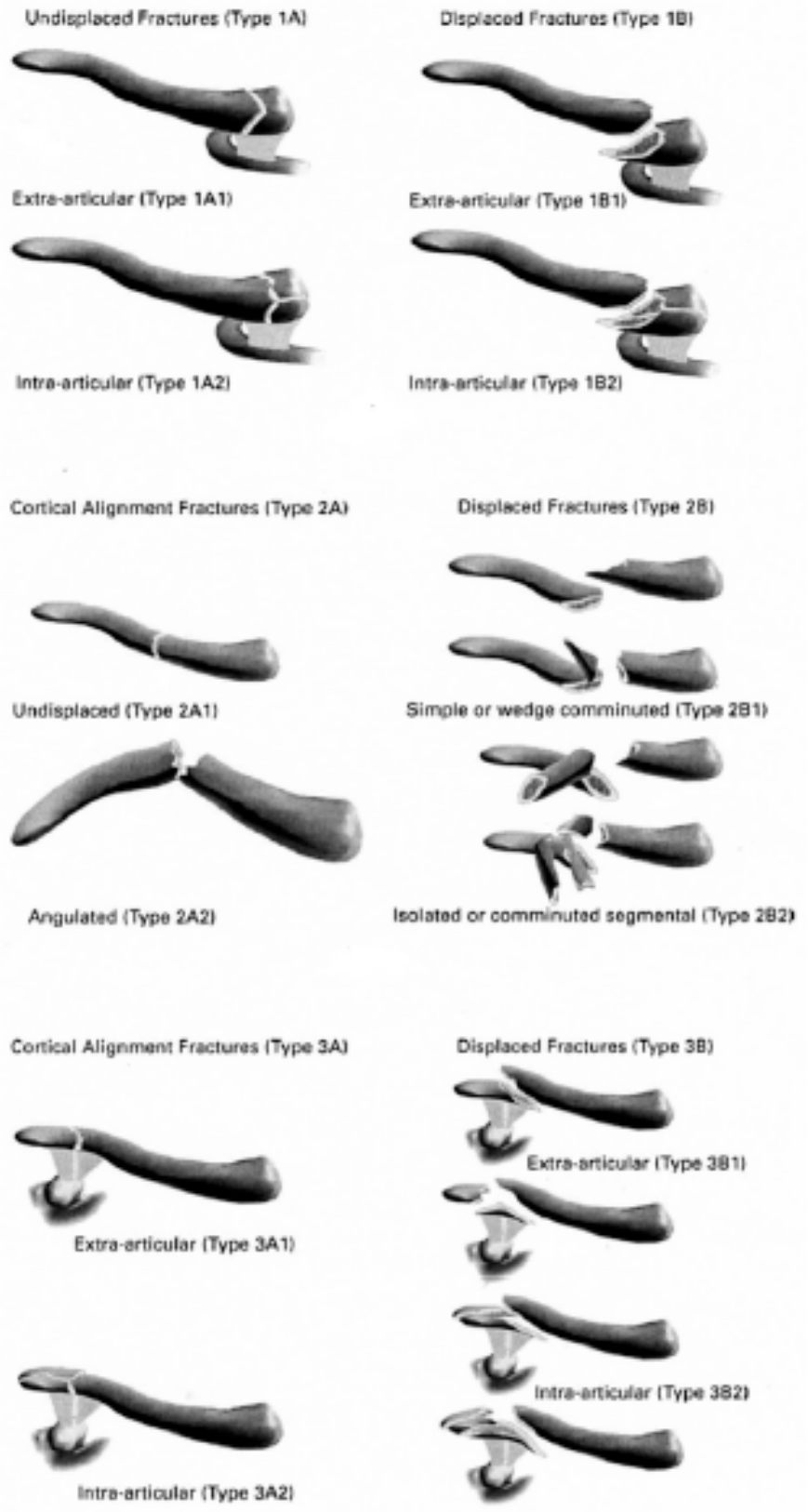
(B) conoid torn, trapezoid attached

Type III - fractures of the articular surface

Type IV - periosteal sleeve fracture (children)

Type V - comminuted with ligaments attached neither proximally nor distally, but to an inferior comminuted fragment

Robinson (31) has proposed an Edinbugh classification:



Type 1 medial

A nondisplaced

A1 extraarticular

A2 intraarticular

B displaced

B1 extraarticular

B2 intraarticular

Type 2 middle

A cortical alignment

A1 nondisplaced

A2 angulated

B displaced

B1 simple or single butterfly fragment

B2 comminuted or segmental

Type 3 distal

A nondisplaced

A1 extraarticular

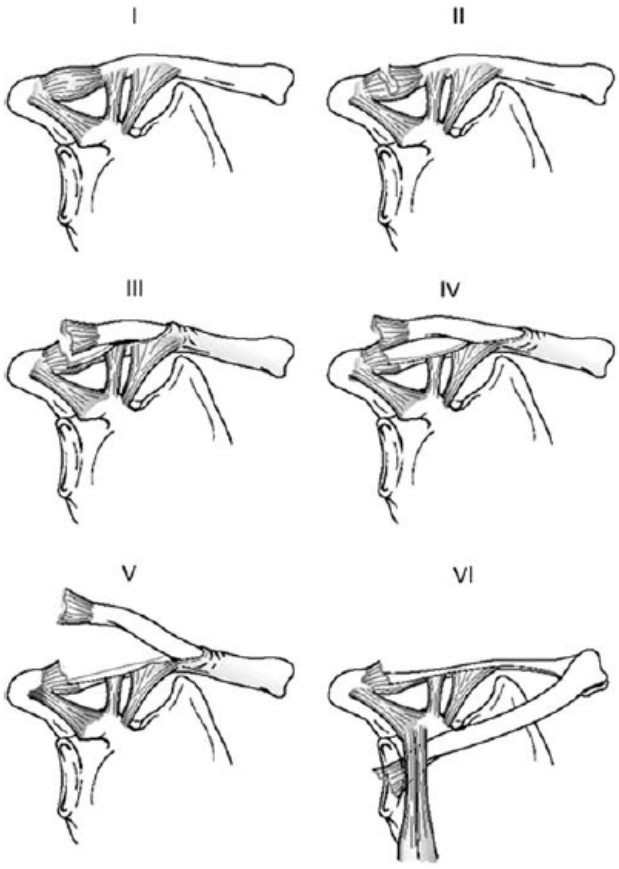
A2 intraarticular

B displaced

B1 extraarticular

B2 intraarticular

In children, distal clavicular injuries lateral to the coracoclavicular ligament and injuries to the acromioclavicular joint are categorized by a system proposed by **Dameron and Rockwood:**



Dameron and Rockwood classification for fractures of the lateral end of clavicle (64)

Type I - Acromioclavicular injuries are caused by low-energy trauma and are characterized by mild strains of the ligaments.

Type II - Complete disruption of the acromioclavicular ligaments, with mild damage to the superolateral aspect of the periosteal sleeve. Mild instability of the distal clavicle results from this type of injury, and minimal widening of the acromioclavicular joint may be seen on an x-ray.

Type III - Complete disruption of the acromioclavicular ligaments occurs in addition to a large disruption in the periosteal sleeve. Similar soft tissue disruptions are seen in

Type IV - Similar to type III with additional posterior displacement of clavicle and is often embedded in the trapezius muscle; axillary lateral x-ray may be required to identify the posterior clavicular displacement.

Type V - similar to type III injuries; the superior aspect of the periosteal sleeve is completely disrupted in type V injuries. This allows displacement of the distal clavicle into the subcutaneous tissues, occasionally splitting the deltoid and the trapezius muscles. On an AP x-ray, the coracoid-clavicle interval is more than 100% greater than the contralateral uninjured side.

Type VI - Distal clavicle is displaced inferiorly, with its distal end located inferior to the coracoid process

7. MATERIAL AND METHODS

This study is a descriptive analysis, approved by the Institution Review Board and the Ethic Committee for the evaluation of the results of hook plate fixation for acromioclavicular joint disruption (Rockwood and Young III-VI) and unstable fractures of the lateral end of clavicle (Neer type II-III).

7.1 AIMS AND OBJECTIVES:

The aim of this study a case series intended to analyze:

1 The outcome of hook plate fixation for the fracture of the lateral end of clavicle and acromioclavicular joint disruptions operated in our hospital.

2. To assess the need for repair of the acromioclavicular capsule, ligaments and coracoclavicular ligaments.
3. To assess the reduction of the joint and stability.
4. To identify the complications related with this implant.
5. To assess the need and indication for implant removal.
6. To assess the time taken to reach pre-injury functional status.

7.2 INCLUSION CRITERIA

1. All acromioclavicular joint disruptions of Tossy type III (Rockwood and Young type III-VI) either acute or chronic symptomatic.

2. All fractures of the lateral end of clavicle of Neer type II and III (Craig II and VI) either acute or with painful nonunion.

3. Retrospectively from and prospective till November 2011

4. All cases were operated in our hospital.

5. Minimum of 6 months of post-operative follow up

6. All surgeries done at our centre

7.3 METHOD

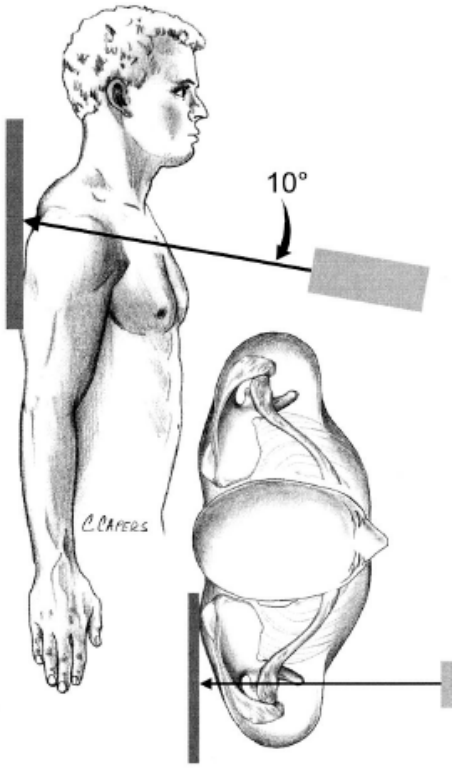
This study is descriptive study of patients from June 2008 to November 2010.

We reviewed all patients who fit our criteria and had undergone surgery with our local customized hook plate and in our hospital. All cases from June 2008 to November 2010 were reviewed.

All operations were done by surgeons of our hospital

1. All patients were either from the Out-patient department of the Emergency
2. Preoperative X-ray of shoulder in AP and Axillary view were taken.
3. The injuries were classified as per the inclusion criteria.
4. All surgeries were performed in a specified manner
5. A locally customized hook plate were used
6. Specified postoperative protocol was followed for all patients.
7. Outcome was measured based on DASH questionnaire and Constant score at intervals of 6, 12, 24 and 52 weeks by one single examiner.
8. Radiological assessment was done at 6, 12, 24 and 52 serial intervals.
9. Signs suggestive of impingement, hardware failure, osteolysis and arthritis of the AC joint were sought for.
10. Implant removal was done at a minimum period of 3 months postoperative patients were symptomatic to the above mentioned.
11. Stress Zanca view (5 kgs) of both shoulders was taken after implant removal to assess the stability of the AC joint and CC ligament.

12. Wound sepsis, time taken to bony union and reaching pre-fall injury status were also noted



Zanca view for the shoulder (6)

The hook plates we used were locally customized - a 6 hole, 3.5mm dynamic compression plate for AC joint disruptions and a minimum 8 hole, 3.5 mm reconstruction plate for fractures of the lateral end of clavicle- by cutting, bending and polishing the plate. The Prosthetic and Orthotic workshop of our hospital is where the primary investigator of this study fabricated all the plates except the plates used in the cases done before initiation of this study. The plate had a hook with posterior offset so as to avoid entry into the AC joint capsule and was hooked

beneath the acromion and posterior to the AC joint capsule. It was made with a height of 11 or 12 mm and hook length of 10 mm.

Hook plate made from 6 holes 3.5mm DCP

Hook plate made from 8 holes Reconstruction plate

The Reconstruction was selected because of its contourable capability for the fractures of the lateral end of clavicle

The cost of the plate with the screws came to between Rs 1800/- to Rs 2100/-.

All procedures were done with the patient in a beach chair position

An incision along the superior margin of the lateral clavicle running posterior to the acromion joint was used in all cases

Negligible soft tissue dissection and handling was practiced. The only soft tissue dissection was the cutting of the deltotrapezial fascia while the AC joint was left undissected. A needle was used to identify the AC joint and also as a guide to the

entry point of hook insertion. AC depth was measured with a depth gauge and the appropriate hook plate used.

For the AC joint disruption, a 3 hole plate made from 3.5mm DCP with 3.5mm cortical screws were used while for fractures of the lateral of clavicle, minimum of 8 or more hole plate, made from Recon plate, was used so as to get 3 bicortical screws in the proximal fragment.

Ligament repair was not done in any of the cases and deltoid and trapezium fascia was resutured back at the time of closure. A tube drain was placed after skin suturing.

The surgical procedure described above took about 45 minutes for completion.

Pendulum exercises were started on the 2nd post operative date and passive mobilization started as patient tolerated. Within 3 weeks active exercises were started and full range of movement was started after 3 weeks.

We have used the DASH questionnaire, Quick DASH score and Constant score as they reflect the subjective and objective perspective of the shoulder function. The range of movement as required in the Constant score was measured with a goniometer. The DASH and quick DASH scores range from 0-100 where zero is the best score and indicates excellent results. Similarly score of 100 indicates poor result. For the constant score, a top score of 100 indicates highest and excellent results while zero indicates least score and poor result. The forms were filled at each visit and at which time they were evaluated for signs of implant failure, irritation, impingement or infection.

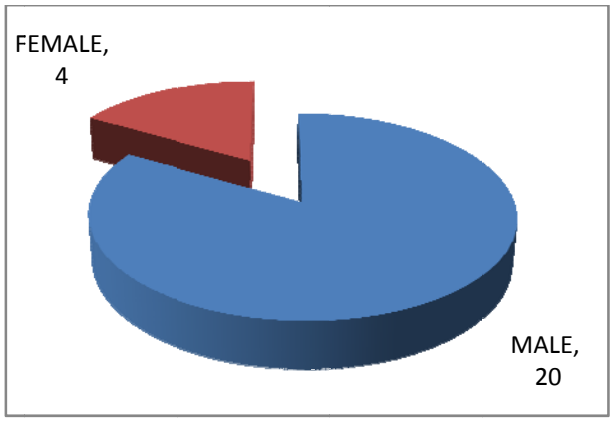
X-rays were taken preoperative, immediate postoperative and subsequently at 6 week and 6 months. Placement of plate, reduction of AC joint or fracture, implant loosening, osteolysis at the tip of the hook, cut out of the hook and union were assessed at serial intervals.

Signs to elicit subacromial impingement were done at each visit and these included the Neer impingement sign, Hawkins-Kennedy sign and Jobe supination test.

Zanca view was taken to assess the coracoclavicular reduction as compared to the opposite side. Stress Zanca view was taken, after the implant removal, to assess the integrity of healed soft tissue at the AC joint.

8. RESULTS

For this descriptive study there were of 24 patients identifies consisting of 4 retrospective cases (identified from the hospital surgery register) while the rest 20 were prospectively registered from March2009 to May 2010. They comprised of 20 male and 4 female.

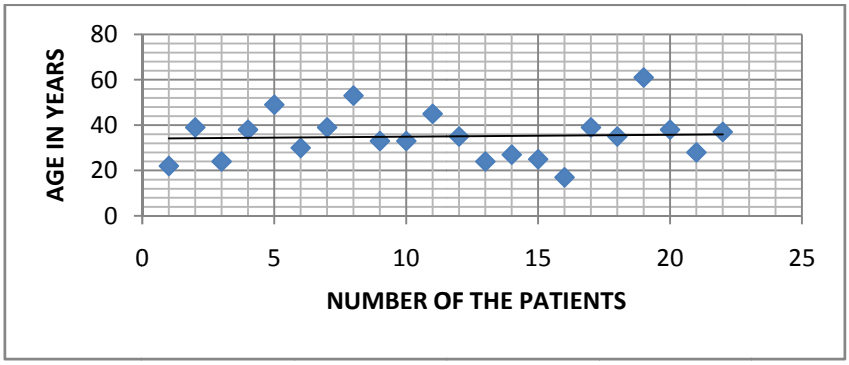


Twelve were fresh fractures of the lateral end of clavicle, 9 AC joint disruptions and 3 painful nonunions

Fifteen were right shoulders and 9 were left shoulders.

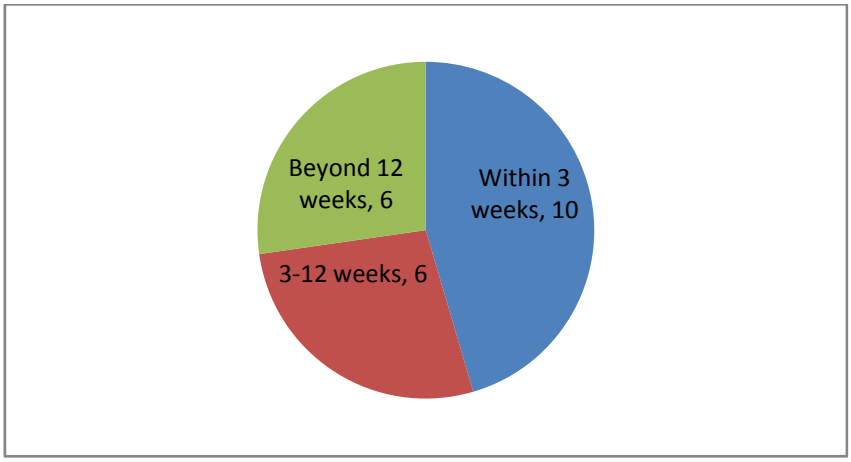
Two patients were lost to follow- up and excluded from the study.

In this study, 22 fulfilled the inclusion criteria and hence included in the study.



The time of arrival of patients after injury has been depicted in the pie chart below.

It shows 10 patients arrived within 3 weeks while 6 patients arrived between 3-6 weeks and beyond 12 weeks respectively.

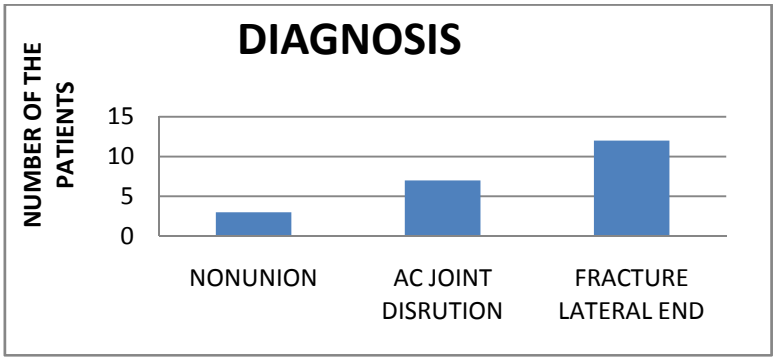


A total of 19 male and 3 female patients participated in the study with a mean age of 35 years (17years to 61years) comprising of :

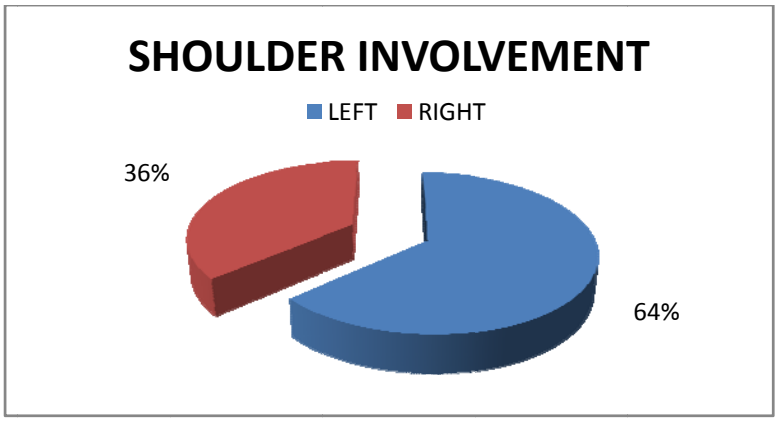
Eleven fractures of the lateral end of clavicle,

Eight AC joint disruptions and

Three painful nonunions, one of whom was a fracture of the lateral end of clavicle with associated AC joint instability.



Fourteen patients had a left shoulder and 8 had right shoulder injury.



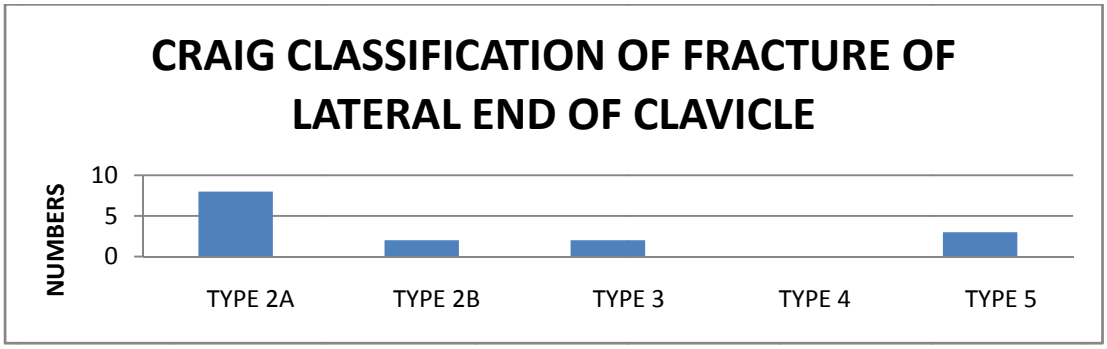
Four patients had associated fractures:

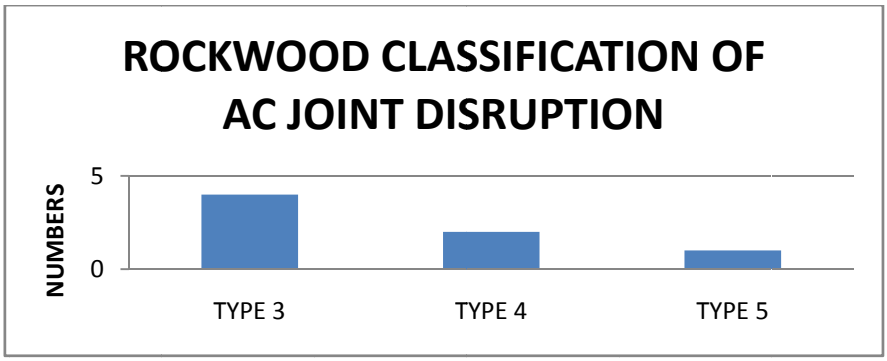
1. Glenoid of scapula
2. Closed distal femur fracture
3. Anterior cruciate ligament tear, medial collateral ligament tear, sacroiliac joint disruption and acetabulum fracture
4. Unreduced dislocation of 4th PIP joint of the ipsilateral side.

All were as a result of a road traffic accident except for 2 patients who had a fall from a ladder and a sport injury respectively.

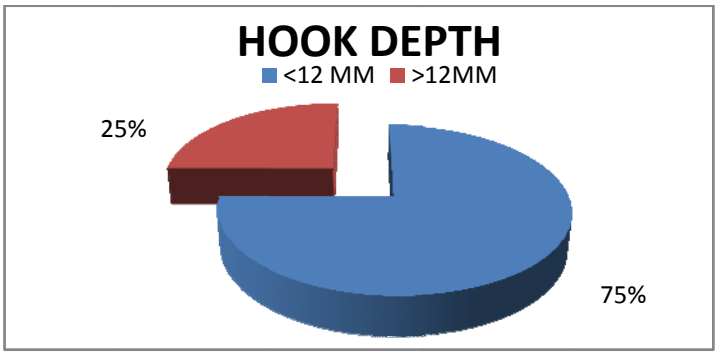
Six of the total patients came to the hospital with no delay.

There were a total of 15 plates (9 fractures of the lateral end of clavicle and 3 painful nonunions) fabricated from a recon plate while 7 plates were from a 3.5mm DCP.





The initial hook plate used in the 3 retrospective cases had larger depth (15mm and 16 mm) but for all the prospective cases, AC joint depth was kept at a range of 10-12mm with a hook length of 10-11mm.



All the patients had a unified surgical approach and operative procedure. The post operative protocol regarding medication and physiotherapy was also unified (as mentioned earlier).

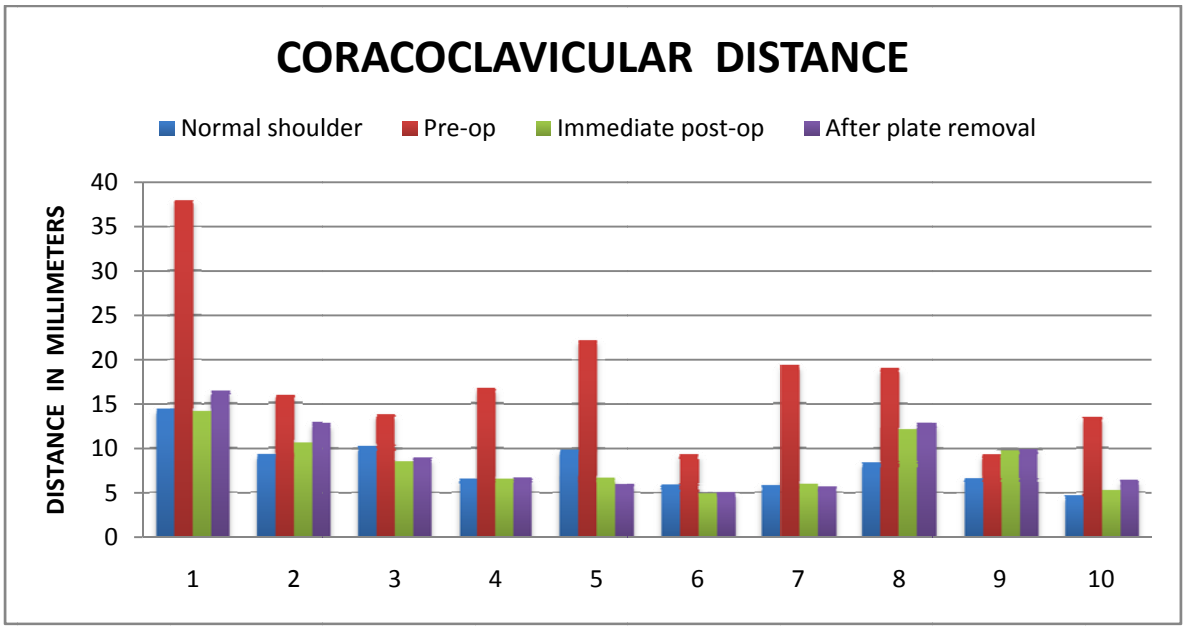
One patient had a resection of the lateral end of clavicle followed by hook plate fixation for painful nonunion with associated arthritis and instability of the AC joint.

Follow-up period ranged from 6 months to 2 year at a mean of 30 weeks.

DASH, quick DASH and constant scoring were done at each visit of the patient.

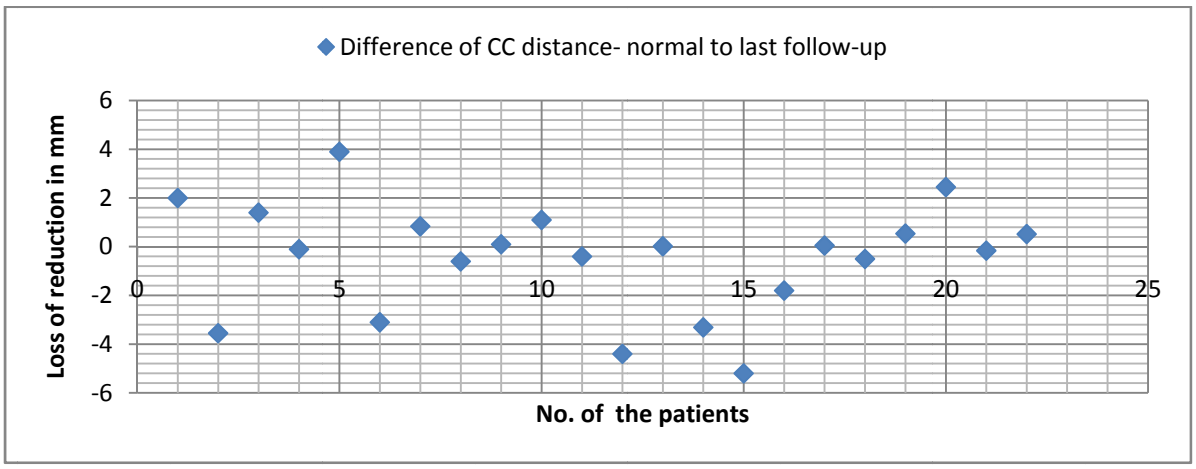
The coracoclavicular distances of both shoulders was measured radiologically (using the digital scale of the GE Centricity clinical workstation) from the x-rays taken at intervals of pre-operative, immediate post operative and at implant removal. Duration

to union, identification of complication was also assessed radiological. Signs of impingement, rotator cuff injury, shoulder stiffness and implant failure were checked for at each visit.



Graph depicting coracoclavicular distance at various intervals of treatment

The above graph is of the 10 patients who had their implant removed and the coracoclavicular distance was calculated in comparison of normal shoulder to the various intervals of the operated shoulder.



The difference in reduction of the coracoclavicular distance of the normal (unaffected) shoulder to the operated (affected) at the last follow-up. The zero is reference to normal and positive variation is under-reduced while negative variation is over-reduced.

Of the 22 patients, 15 patients had reduction in the range of +2mm to -2mm while 20 patients had a reduction in the range of +4mm to -4mm. Only 2 patients had an over-reduction in excess of -4mm.

The functional outcome was assessed using DASH, Quick DASH and Constant score.

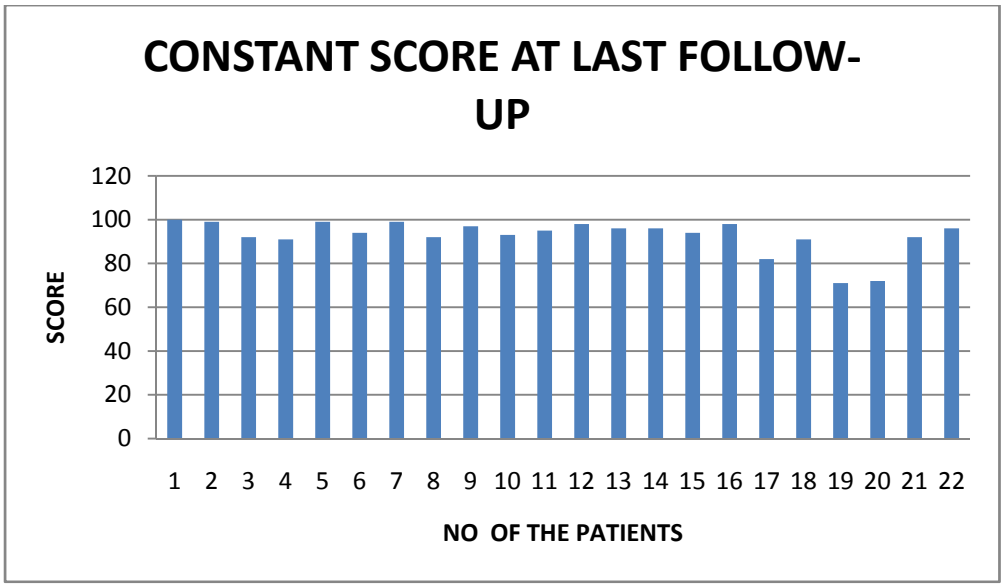
At the last follow-up, 19 patients had an excellent outcome as assessed by Constant score, DASH and Quick DASH scores.

Two patients had good outcome and 1 had poor outcome.

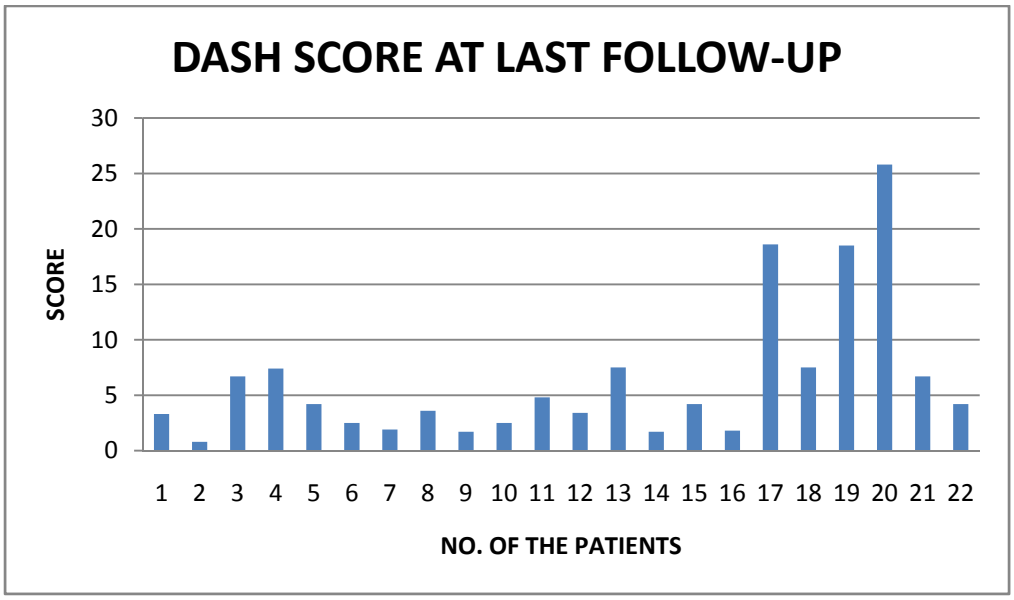
The mean scores at the last follow-up were:

Constant score was 92.5 (range 71-100),

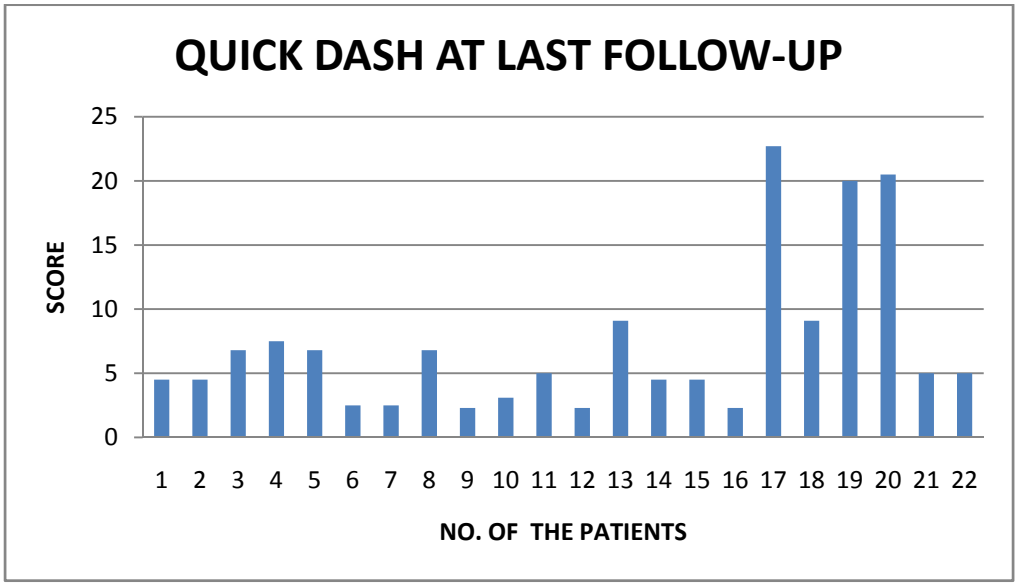
DASH score was 6.3 (range 0.8- 25.8) and mean quick DASH score was 7.15 (range 2.3- 22.7).



Constant score is obtained from subjective and objective scoring including pain, activities of daily living, range of movement and muscle power. Excellent score is 100 and zero indicating poor score



DASH questionnaire has 30 questions to be answered by the patient relating to activities of daily living, pain and confidence. Poorest outcome is 100 while the best outcome is a score of zero.

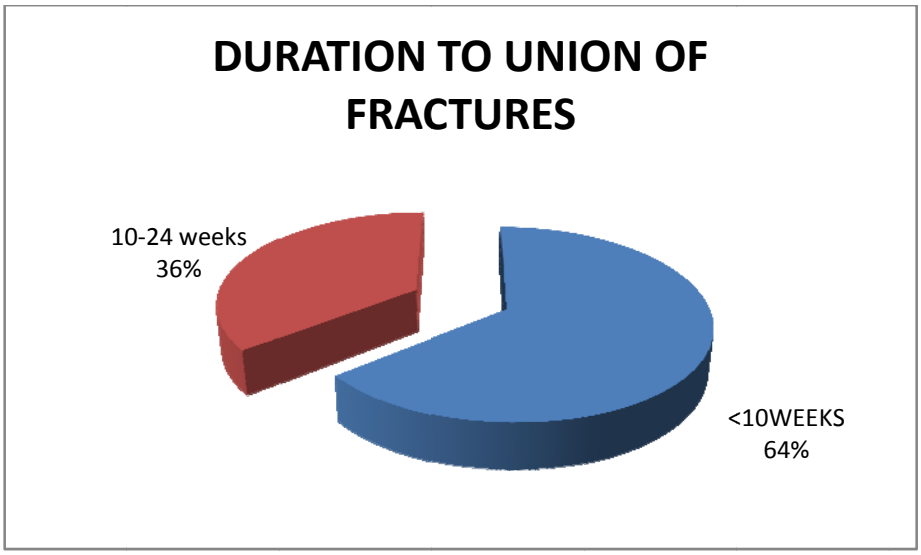


Quick DASH is an abbreviated version of DASH and contains only 11 questions out of the30 in DASH. The quick DASH is statistically equal to DASH score.

Of the 3 patients who did not have excellent, patient No.17 had excision of the lateral end of clavicle for painful nonunion with arthritis of the AC joint and last follow-up was at 24 weeks 9 (there has been a gradual improvement of scores throughout the 6 post op weeks). Patient No.19 had shoulder stiffness and had hydrostatic saline distension at 12 weeks and at present is due shortly to have the implant removed because of osteolysis. Patient No.20 had developed bilateral shoulder stiffness (probable idiopathic frozen stiffness) and had the implant removed recently and will be reassessed after 6 weeks.

Ten patients had their implants removed during the course of this study for reasons of impingement and osteolysis.

Union in the fracture cases was seen in all cases at a mean duration of 13 weeks (6-24 weeks).

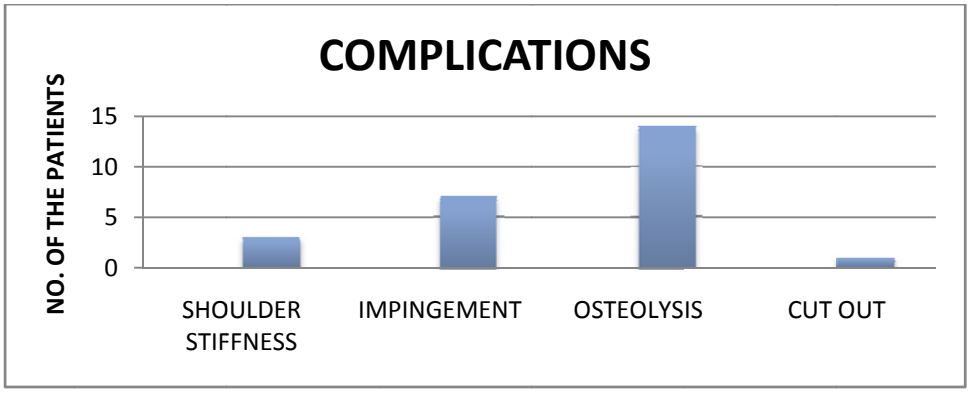


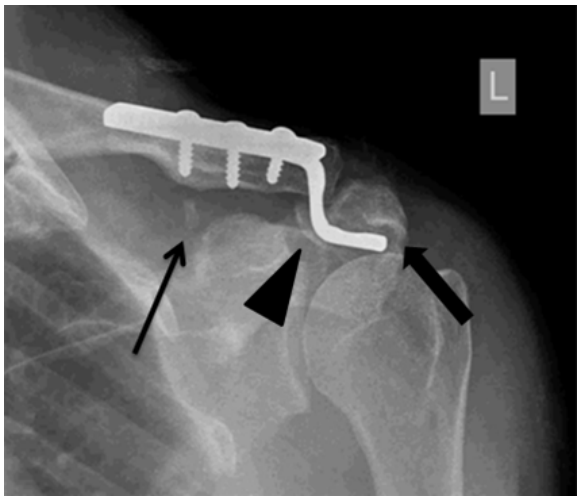
None of the patients had infection. One patient developed a sterile stitch granuloma at 8th post op week.

Three patients developed calcification of the CC ligament or AC joint capsule. Two had calcification of coracoclavicular ligament and 1 had calcification of AC joint capsule

The complications seen in our study were:

1. Impingement 7
2. Osteolysis at the tip of the hook 14
3. Cut out of hook 1



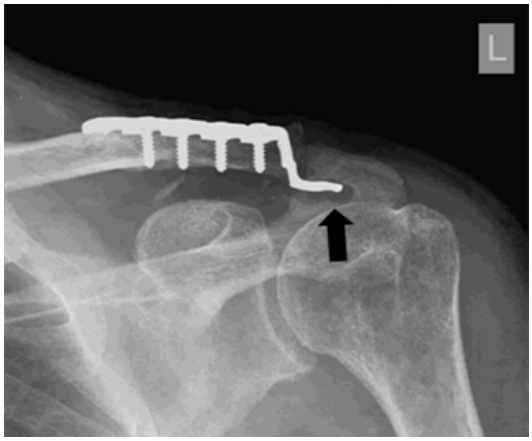


Thin arrow: Calcification of CC ligament
Arrow head: Calcification of AC joint capsule
Block arrow: Osteolysis at the tip of the hook

Three patients developed early impingement (< 8 weeks) and 4 developed it late (>8 weeks). One patient had an associated feature of rotator cuff injury noticed at 8 weeks and which resolved after implant removal at 24 weeks.

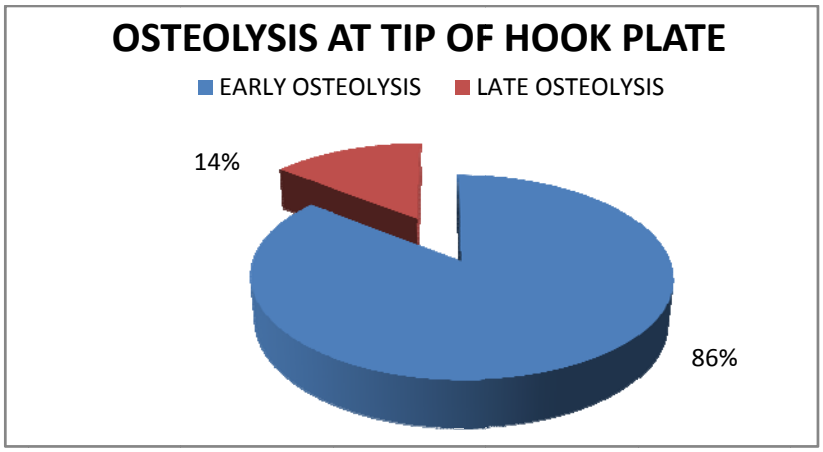
One patient had signs of impingement preceding the cut-out of hook at 24 weeks.

Of the 14 who developed osteolysis, early osteolysis (of <6 weeks duration) was seen in 12 while 2 developed it at a later date (beyond >6 weeks duration) and these correlated with the worsening of DASH and Constant score.



Arrow indicates the osteolysis at the tip of the hook

The osteolysis was found to re-ossify after implant removal.

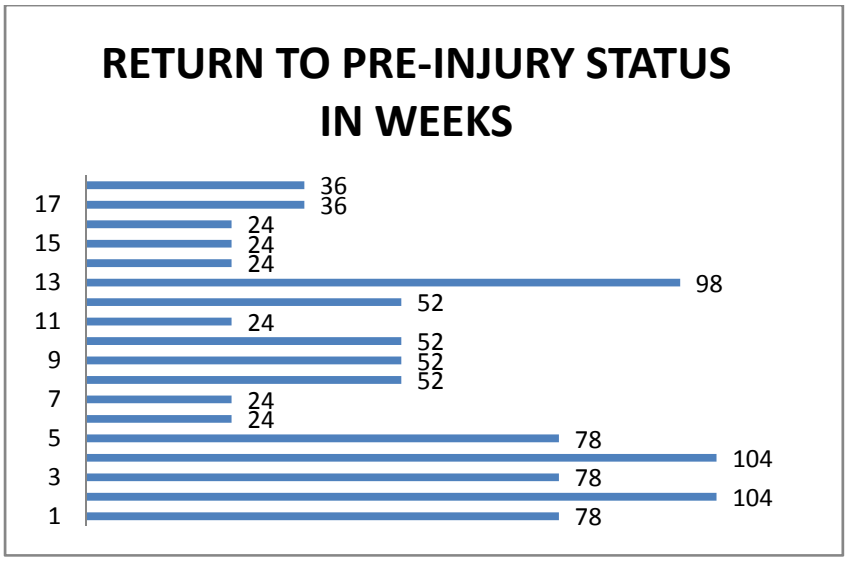


Three patients developed frozen shoulder. Two were considered to be idiopathic frozen shoulders- one had developed global restriction of the operated shoulder 9 months after surgery and the other because of bilateral and global restriction of shoulder movements developed 3 months of surgery. The third patient developed a frozen shoulder after uncontrolled diabetes mellitus (type 2).

Two patients needed hydrostatic saline distension followed by intense physiotherapy. All the 3 patients improved significantly with intensive physiotherapy.

One of the 3 patients with nonunion, was found to have developed arthritis of the AC joint at the last follow-up.

In all 10 cases where the implant were removed, no increase in the CC distance (demonstrated by stress Zanca views) was observed implying the healing of the AC joint capsule and ligament.



Return to pre-injury status was seen in 18 patients of the 22.

Eighteen patients returned to pre-injury status at a mean of 53.5 weeks (24-104 weeks). Six patients returned to pre-injury status at 6 months while 2 returned at 9 months and 4 at 12 months of surgery.

Though the remaining 6 patients returned to work within 1 year, the return to pre-injury status took 1 ½ to 2 years. This may be due to the presence of mild pain at the operated site or due to the development of painful osteolysis.

Of the 4 patients who are yet to return to pre-injury status, 2 are awaiting implant removal for impingement, 1 recently underwent implant removal for impingement and is recuperating from the surgery. The last patient is yet to return after the 24th week post-operative follow-up.

9. DISCUSSION

Treatment for unstable fractures of the lateral end of clavicle and AC joint disruptions have been shown historically to be an area of much debate in respect to the indications, choice of treatment procedure and choice of implant. Historically a variety of implants have been used such as Kirschner wires(65; 44; 52), tension band wires around coracoid-clavicle, transfixation of clavicle to coracoid with screw (66), repair of CC ligament with augmentations (67; 47), endobuttons (68) and the hook plate (3; 19; 69; 34; 53). Others advocate the excision of the lateral end of clavicle in chronic painful dislocations (30; 70). Debate as to the use of synthetic (71) or autologous fascia slings and tendons for repair of CC ligament (23; 24; 72; 73) and its fixation techniques are yet to be resolved. Surgical approaches may be luggage strap, along the clavicle, mini stab incisions or arthroscopic reconstruction of CC ligament (36; 37)
The Weaver Dunn procedure has a weak strength and can result in incomplete reduction or recurrence with a high failure rate of approximately 29% (28)
Kirschner wire fixation has a high rate of migration (19) while the Bosworth screw needed a wide surgical exposure but provided a rigid fixation leading to loss of rotation and screw cut out (74)
In young patients, there is a need to restore anatomical reduction because of high rates of nonunions and shoulder pain and that the ligaments will not heal without surgery.

The use of hook plate in the treatment of AC joint disruptions and fractures of the lateral end of clavicle is shown to be a good and acceptable treatment option (3; 75; 76).

AC joint dislocations result in an inferior sag of the scapula (33) and stability at this joint must be achieved either by repair of the ligaments and/or stabilizing with a plate or other fixation devices. Implants like endobuttons^{TM} (Smith & Nephew) need not be removed and this avoids an additional surgery to the patient (50). In regards to the use of a hook plate, there are debatable statements regarding retaining the implant for a more longer duration as against removal when the patient is symptomatic (77)

Most of the patients in this study had an excellent or good outcome which is similar to the findings of various other studies(1; 3; 9; 19; 33; 53; 54)

There is literature questioning the need for either simultaneous reconstruction or repair of the ligaments along with hook plate method of fixation, further suggesting implant removal after radiological or clinical indication and /or reconstruction after plate removal depending on the instability.(33)

In this study, 19 patients had an excellent outcome as assessed by Constant score, DASH and Quick DASH scores. 2 patients had good outcome and 1 had poor outcome (he has developed a frozen shoulder and uncontrolled diabetes). These results are comparable to other studies using a hook plate.(3; 53; 54)

Of the 2 patients who had good outcome, one had his implant removed recently; another has developed impingement and is awaiting implant removal, while the third who had a resection of the lateral end of clavicle (with arthritis of AC joint) followed by

hook plate stabilization of AC joint and will be arriving for follow-up and implant removal at a later date.

We have noted the following complications: impingement occurred in 7, osteolysis at the tip of the hook in 14, frozen shoulder in 3 and cut out of hook in 1 patient.

Three results are comparable with other studies (3; 53; 54) though the exact reason of shoulder stiffness is unknow, it appears to be a post-traumatic frozen shoulder.

The presence of osteolysis between the plate and the acromion has been attributed to the rotational movement (micro motion) which occurs with abduction resulting in rotation of clavicle and the hook plate in respect to the acromion (78).

In our study, 14 patients (63%) developed osteolysis which was temporary and resolved after implant removal, the incidence of which is similar to one (1) but higher than some other studies.(3; 54)

The origin of impingement pain may be as a result of decrease in subacromial space or the irritation of the subacromial bursa.(78)

All 8 patients who had their implants removed showed structural integrity of the AC joint when tested with stress Zanca view.

The time taken to return to pre-injury status was at a mean of 51 weeks, this is partly attributed to the lack of personal initiative from the patients, lack of timely follow-up and inability to attend physiotherapy session due to distance and financial burdens.

10. SUMMARY AND CONCLUSION

From the analysis of this study the following were noted:

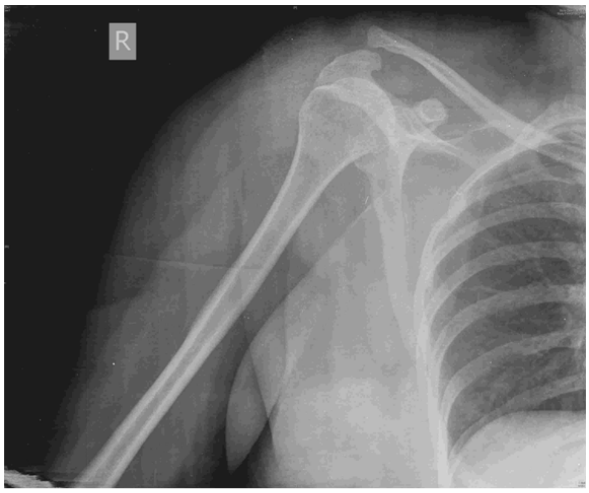
1. Hook plate is a good option for treatment of AC joint disruption and unstable fracture of the lateral end of clavicle.
2. Our customized implant has been shown to be cost effective compared with imported hook plates.
3. Limited use of instrumentation for the procedure
4. Short duration of the surgical procedure
5. Low incidence of complications
6. Good objective and subjective outcomes
7. Stability to the AC joint attained without the need for ligament repair or reconstruction.
8. Short learning curve
9. Implant removal is advisable but the decision depends on the presence or absence of osteolysis and impingement.

The hook plate is a relatively less analyzed method of treatment for displaced fractures of the lateral end of clavicle and acromioclavicular joint disruptions. These injuries are rare and diagnosing and treating them proves to be a challenge as there is an array of treatment options, all of which are associated with their own set of problems.

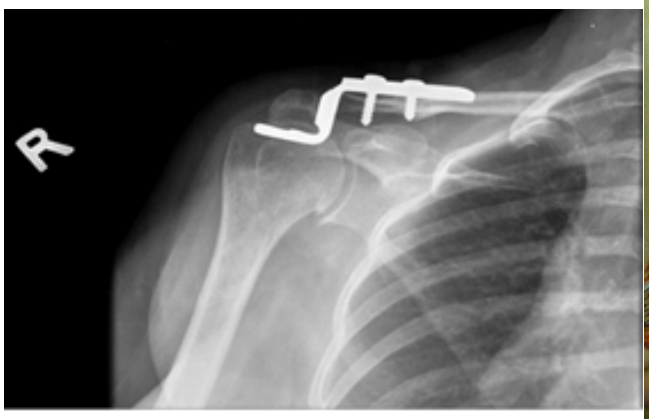
Secondly, there is a lack of unified consensus on treatment for these injuries. When we started treating these injuries, the availability of prefabricated plates did not exists

other modalities of treatment had a higher rate of complications. In India, where there are no nationalized health schemes, most patients will have to bear all costs of the treatment, the hook plates manufactured by AO Synthes™ or the Endobuttons™ (Smith & Nephew) marketed are expensive and may not be affordable

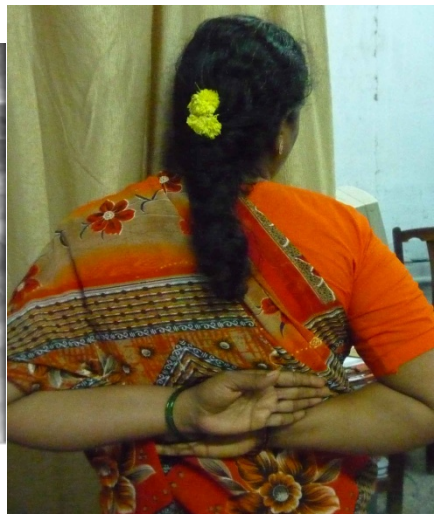
The hook plate customized in our hospital can be readily duplicated in any small setup, be it semi urban or rural, and the procedure is simple enough to be practiced by all orthopedicians with good results.



38 year old lady presented with an alleged history of RTA and complained of pain over the right shoulder



Immediate post-op



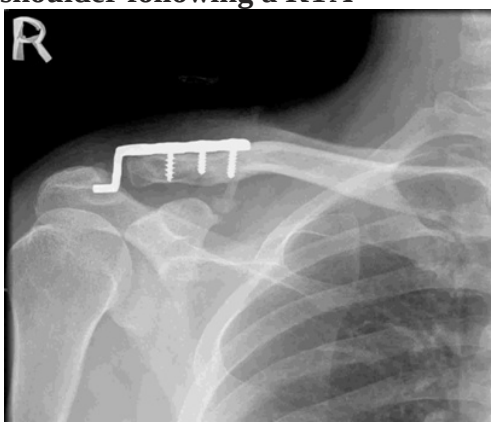
Stress view after implant removal

22 year male presented with right shoulder pain and deformity following a RTA

Immediate post op

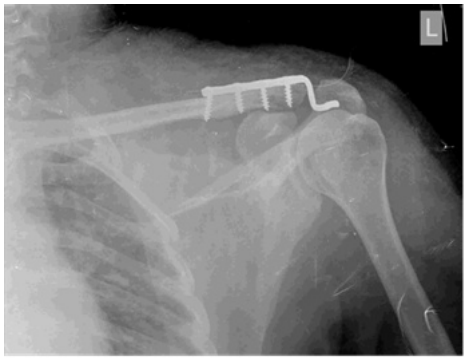
35 year male with pain over the right shoulder following a RTA

Immediate post-operative



At 9 month post op period

32 years male with pain over the left shoulder following a RTA



Immediate post-op

Stress Zanca view after implant removal

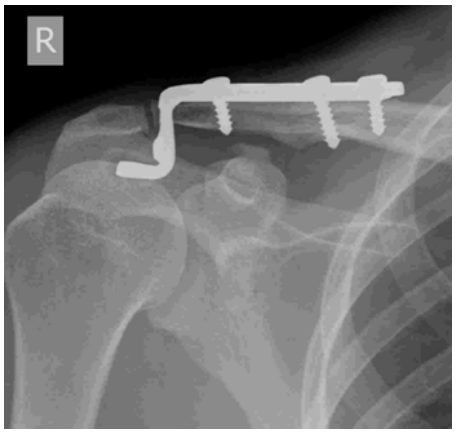
37 year male with an alleged history of RTA came with pain and deformity at the left shoulder

Immediate post operative period

At 10 months post-op

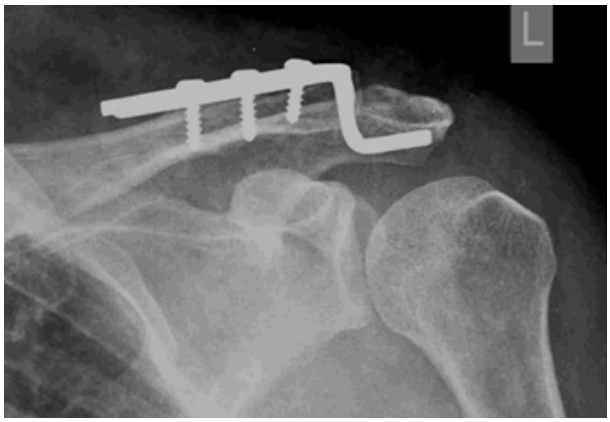
24 year male post RTA

Immediate post-op

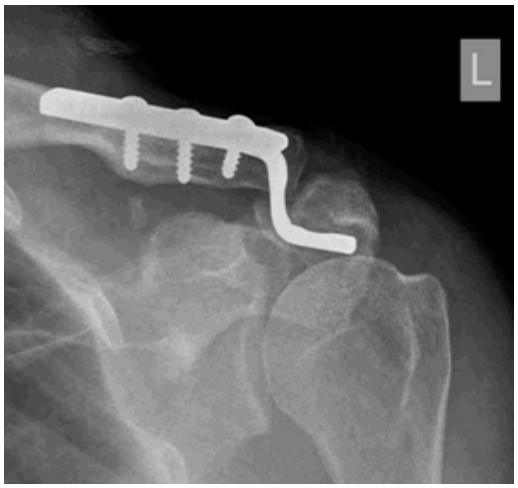


At last follow-up (2 years)

Pre-op of 35 year male following a RTA



Immediate post-op



Last follow-up (2 years)

CONSTANT SCORE

1. Pain

- ☐ Severe
- ☐ Moderate
- ☐ Mild
- ☐ None

2. Activity Level (check all that apply)

- ☐ Unaffected Sleep
- ☐ Full Recreation/Sport
- ☐ Full Work

3. Arm Positioning

- ☐ Up to Waist
- ☐ Up to Xiphoid
- ☐ Up to Neck
- ☐ Up to Top of Head
- ☐ Above Head

4. Strength of Abduction [Pounds]

- ☐ 0
- ☐ 1-3
- ☐ 4-6
- ☐ 7-9
- ☐ 10-12
- ☐ 13-15
- ☐ 15-18
- ☐ 19-21
- ☐ 22-24
- ☐ >24

RANGE OF MOTION

5. Forward Flexion

- ☐ 31-60 degrees
- ☐ 61-90 degrees
- ☐ 91-120 degrees
- ☐ 121-150 degrees
- ☐ 151-180 degrees

6. Lateral Elevation

- ☐ 31-60 degrees
- ☐ 61-90 degrees
- ☐ 91-120 degrees
- ☐ 121-150 degrees
- ☐ 151-180 degrees

7. External Rotation

- ☐ Hand behind Head, Elbow forward
- ☐ Hand behind Head, Elbow back
- ☐ Hand to top of Head, Elbow forward
- ☐ Hand to top of Head, Elbow back -
- ☐ Full Elevation

8. Internal Rotation

- ☐ Lateral Thigh
- ☐ Buttock
- ☐ Lumbosacral Junction
- ☐ Waist (L3)
- ☐ T12 Vertebra
- ☐ Interscapular (T7)

DASH SCORE

Please rate your ability to do the following activities in the last week.

1. Open a tight or new jar

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

2. Write

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

3. Turn a key

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

4. Prepare a meal

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

5. Push open a heavy door

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

6. Place an object on a shelf above your head

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

7. Do heavy household chores (eg wash walls, wash floors)

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

8. Garden or do yard work

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

9. Make a bed

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

10. Carry a shopping bag or briefcase

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

11. Carry a heavy object (over 10 lbs)

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

12. Change a lightbulb overhead

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

13. Wash or blow dry your hair

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

14. Wash your back

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

15. Put on a pullover sweater

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

16. Use a knife to cut food

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

17. Recreational activities which require little effort (eg cardplaying, knitting, etc)

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

18. Recreational activities in which you take some force or impact through your arm, shoulder or hand (eg golf, hammering, tennis, etc)

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

19. Recreational activities in which you move your arm freely (eg playing frisbee, badminton, etc)

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

20. Manage transportation needs (getting from one place to another)

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

21. Sexual activities

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

22. During the past week, *to what extent* has your arm, shoulder or hand problem interfered with your normal social
activities with family, friends, neighbours or groups?

☐ **Not at all** ☐ **Slightly** ☐ **Moderately** ☐ **Quite a bit** ☐ **Extremely**

23. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem?

☐ **Not limited at all** ☐ **Slightly limited** ☐ **Moderately limited** ☐ **Very limited** ☐ **Unable**

Please rate the severity of the following symptoms in the last week

24. Arm, shoulder or hand pain

☐ **None** ☐ **Mild** ☐ **Moderate** ☐ **Severe** ☐ **Extreme**

25. Arm, shoulder or hand pain when you performed any specific activity

☐ **None** ☐ **Mild** ☐ **Moderate** ☐ **Severe** ☐ **Extreme**

26. Tingling (pins and needles) in your arm, shoulder or hand

☐ **None** ☐ **Mild** ☐ **Moderate** ☐ **Severe** ☐ **Extreme**

27. Weakness in your arm, shoulder or hand

☐ **None** ☐ **Mild** ☐ **Moderate** ☐ **Severe** ☐ **Extreme**

28. Stiffness in your arm, shoulder or hand

☐ **None** ☐ **Mild** ☐ **Moderate** ☐ **Severe** ☐ **Extreme**

29. During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder or hand?

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **So much I can't sleep**

30. I feel less capable, less confident or less useful because of my arm, shoulder or hand problem

☐ **Strongly disagree** ☐ **Disagree** ☐ **Neither agree nor disagree** ☐ **Agree** ☐ **Strongly agree**

Quick DASH score

1. Open a tight or new jar

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

2. Do heavy household chores (eg wash walls, wash floors)

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

3. Carry a shopping bag or briefcase

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

4. Wash your back

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

5. Use a knife to cut food

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

6. Recreational activities in which you take some force or impact through your arm, shoulder or hand (eg golf, hammering, tennis, etc)

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **Unable**

7.During the past week, *to what extent* has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbours or groups?

☐ **Not at all** ☐ **Slightly** ☐ **Moderately** ☐ **Quite a bit** ☐ **Extremely**

8. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem?

☐ **Not limited at all** ☐ **Slightly limited** ☐ **Moderately limited** ☐ **Very limited** ☐ **Unable**

Please rate the severity of the following symptoms in the last week

9. Arm, shoulder or hand pain

☐ **None** ☐ **Mild** ☐ **Moderate** ☐ **Severe** ☐ **Extreme**

10. Tingling (pins and needles) in your arm, shoulder or hand

☐ **None** ☐ **Mild** ☐ **Moderate** ☐ **Severe** ☐ **Extreme**

11. During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder or hand?

☐ **No difficulty** ☐ **Mild difficulty** ☐ **Moderate difficulty** ☐ **Severe difficulty** ☐ **So much difficulty I can't sleep**

KEY TO THE EXCEL LOG BOOK

1. AGE MEASURED IN YEARS
2. SEX M= MALE F= FEMALE
3. DIAGNOSIS 1= AC JOINT DISRUPTIONS

   2= FRACTURE OF THE LATERAL END OF CLAVICLE

   NU= NONUNION LATERAL END OF CLAVICLE

   ARTH+INS= NONUNION LATERAL END OF CLAVICLE WITH ARTHRITIS OF AC JOINT AND INSTABILITY OF AC JOINT
4. SIDE 1=RIGHT 2=LEFT
5. GRADE BASED ON CRAIG CLASSIFICATION FOR FRACTURES

   ROCKWOOD CLASSIFICATION FOR AC JOINT DISRUPTIONS
6. IMPLANT 1= DCP 2=RECON PLATE
7. ITT INJURT TO TREATMENT DURATION IN DAYS
8. CS CONSTANT SCORE
9. DS DASH SCORE X=WHEN MORE THAN 3

   QUESTIONS NOT ANSWERED HENCE SCORE NOT CALCULATED
10. QD QUICK DASH SCORE
11. NORM* CC DISTANCE (in mm)OF THE NORMAL SHOULDER
12. AFFECT* CC DISTANCE (in mm) OF THE AFFECTED

    SHOULDER
13. AFF-IPO CC DISTANCE (in MM) AT IMMEDIATE POST-OP

    INTERVAL

14.	AFF-END	CC DISTANCE (in mm) AFTER IMPLANT REMOVAL
15.	LIGAMENT	STABILITY OF AC JOINT (Entered as S if stable)
16.	CALCIFICATION	CALCIFICATION OF EITHER CC LIGAMENT OR AC JOINT CAPSULE
17.	AC JOINT	STATUS OF AC JOINT AT LAST FOLLOW UP ANKLYOS= ANKYLOSIS CALCI = CALCIFICATION OF CAPSULE ARTHRIT = ARTHRITIS OF AC JOINT
18.	UNION	DURATION TO RADIOLOGICAL UNION(in weeks)
19.	I/EXIT	IMPLANT EXIT IN WEEKS
20.	OSTEOLYSIS	TIME (in weeks) TO APPEARANCE OF OSTEOLYSIS
21.	LENGTH	LENGTH OF HOOK
22.	DEPTH	DEPTH OF HOOK
23.	COMPLI	COMPLICATIONS SEEN
24.	COMP-WK	TIME (in weeks) TO COMPLICATION APPEARANCE

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