Topic: *Surgical and Functional outcome of reconstruction of Acromio-clavicular joint dislocation*

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By

**Dr Hardik Piyush Agrawat**
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INTRODUCTION

Numerous procedures have been described for the operative management of acromioclavicular joint injuries, but surprisingly little information is available on the ultimate mechanical behavior of the native coracoclavicular ligament complex or on the various methods of reconstruction. Reconstruction of the coracoclavicular ligament was achieved using coracoacromial ligament transfers, woven polyester slings, suture anchors, and Bosworth screws; all reconstructions were tested to failure. It was also found in various studies that there was no significant difference between the contributions of the conoid or trapezoid ligaments in loading configuration. Coracoclavicular slings and suture anchors provided strength similar to that of the coracoclavicular ligament, but with significantly greater deformations. Screw fixation resulted in comparable stiffness and superior strength to the coracoclavicular ligament, but only if bicortical purchase was obtained. Coracoacromial ligament transfers were the weakest and least stiff, and augmentation with another form of coracoclavicular fixation is recommended. Some of the results provide a useful baseline for comparison of the initial performance of reconstructive techniques with the performance of the native coracoclavicular ligament.

The understanding of the biomechanics of the acromio-clavicular (AC) joint still continues to evolve, and treatment methods, both conservative and surgical, continue to be refined. Controversy over the ideal treatment for a type III Acromio-clavicular joint injury persists, with the pendulum swinging once again toward an initial attempt at nonsurgical management. Rehabilitation techniques in conservative treatment have focused on a more functional approach and a quicker return to activities. Some studies have shown that as little as 5 mm need be resected to achieve adequate decompression and pain
relief\textsuperscript{2}. Recent biomechanical studies have re-examined the functional contributions of the four components of the acromio-clavicular ligament in an effort to determine which ones should be preserved during an arthroscopic acromion-clavicular joint resection to avoid destabilizing the joint. The potential pitfalls of acromion-clavicular co-planning during acromioplasty have been examined both clinically and biomechanically. Many methods, articles and paper attempts to bring the most recent issues, concerns, and controversies surrounding the acromio-clavicular joint into focus\textsuperscript{2}.

For currently presented anatomical coracoclavicular ligament repairs issues such as autologous tendon graft versus synthetic suture augmentation and the optimum fixation strategies for both types of reconstruction are not solved. In April 15, 2010 Gregory Waryasz in a comparative study showed primary AC joint fixation, dynamic muscle transfers of the biceps and clavicle hook plate placement have higher complication and failure rates\textsuperscript{3}. Acromio-clavicular joint instability—reconstruction indications and techniques Brent A, Ponce, MD showed suture materials used in the primary fixation being a potential nidus of infection and higher infection rates in them\textsuperscript{4}. Many studies are done to compare the biomechanical properties of different tendon graft repairs to the characteristics of a synthetic polyester augmentation. Anatomical coraco-clavicular ligament repairs were biomechanically tested: 5 mm coraco-clavicular tendon loop with suture fixation, tendon loop with flip button fixation, tendon loop with interference screw fixation versus a double 1.0-mm polyester repair with flip button fixation. A synthetic coraco-clavicular augmentation using a polyester suture provides adequate structural properties compared to a tendon repair\textsuperscript{5}. Therefore the decision for a tendon graft should be made by the necessity of a biologic substrate rather than by the assumption of a biomechanical advantage.
In this study we are performing anatomical reconstruction using Hamstrings tendon graft that replicated the direction and orientation of both the trapezoid and conoid ligaments. By achieving this near normal anatomy by reconstructing the ligament we intend to study the surgical and functional outcome of the reconstruction and also the complications related to it as a part of the procedure.

**ACROMIO-CLAVICULAR JOINT**

The acromioclavicular joint is a diarthrodial articulation with an interposed fibrocartilaginous meniscal disk that links the hyaline cartilage articular surfaces of the acromial process and the clavicle. The joint is stabilized by a combination of dynamic muscular and static ligamentous structures, which allow a normal anatomic range of motion. Because of the transverse orientation of the articulation, direct downward forces may result in shear stresses that cause disruption of these stabilizing structures and create displacement beyond the normal limits. This is evidenced by abnormal positioning of the clavicle relative to the acromion, usually in the superior direction. Acromio-clavicular joint separation is dependent upon the degree of ligamentous injury. The capsular Acromio-clavicular ligaments and the extra-capsular coraco-clavicular ligament are the primary static stabilizers of the Acromio-clavicular joint. The anterior and posterior Acromio-clavicular ligaments are predominantly responsible for maintaining stability in the antero-posterior plane. The two components of the Coraco–clavicular ligament, the trapezoid and conoid ligaments, provide restraint against compression and superior-inferior translation respectively. The deltoid and trapezius muscles are especially important in providing dynamic stabilization when these ligamentous structures are damaged. Treatment of Acromio-clavicular joint separations has been a subject of
debate. Rockwood Classification\textsuperscript{36, Pg17} is widely used to classify Acromio joint injuries and dislocation. Type I and type II injuries are generally accepted to be treated non-operatively in the acute setting. However, reaching a consensus regarding the optimal management of acute type III injuries has been difficult.

Treatment for acute type III Acromio-clavicular joint injuries remains controversial despite randomized trials that indicate success with non-operative treatment in most cases. Many surgeons believe that this degree of displacement leads to muscle fatigue discomfort and difficulty manipulating heavy loads. As a result, operative intervention should be considered in heavy laborers and younger patients who are athletic or unsure of their future careers.\textsuperscript{34}

Type IV, V, and VI injuries generally require surgical intervention. Because the clavicle is so far displaced from the acromial process in the posterior, superior, or inferior direction respectively, conservative management is inadequate. The patient continues to experience pain and dysfunction if the articulation is not reduced and stabilized.

Type I, II, and III injuries that are managed conservatively may result in persistent shoulder pain, dysfunction, or both. Type I and II separations may progress to develop symptomatic degenerative disease. Type III separations may result in impingement symptoms, muscle fatigue discomfort, and/or neurovascular symptomatology. Late surgical management may be required\textsuperscript{34}

**Relevant Anatomy of Acromio-clavicular joint**

The Acromio-clavicular joint is strengthened by the anterior and posterior Acromio-clavicular ligaments. These ligaments are intracapsular and provide stability in the anterior and posterior directions. The fibers of the trapezius and the deltoid muscles provide additional stability.\textsuperscript{35}
The trapezoid and conoid components of the Coraco clavicular ligament add vertical stability. They attach to the coracoid process and the inferior surface of the distal clavicle.

Although not an Acromio-clavicular joint stabilizing structure, the coraco-clavicular ligament is also relevant to the discussion of surgical treatment. This structure runs from the superior surface of the coracoid process to the inferior surface of the acromial process in a nearly horizontal direction. During operative repair of type III injuries, the coraco-clavicular ligament may be resected from its acromial insertion and used to reconstruct the torn coraco-clavicular ligament.

Type III, IV, V, and VI Acromio-clavicular joint separations are, in fact, double disruptions of the superior shoulder suspensory complex (SSSC). The SSSC is a bony and soft-tissue ring composed of the glenoid process, the coracoid process, the coraco clavicular ligament, the distal clavicle, the Acromio-clavicular joint, and the acromial process at the end of a superior bony strut (the mid-shaft clavicle) and an inferior bony strut (the junction of the lateral scapular body and the medial glenoid neck). Type III through type VI separations are characterized by disruptions of both the coraco-clavicular and acromio-clavicular ligaments; therefore, they constitute unstable injuries that must be accounted for or require surgical reduction and stabilization.
The joint is stabilized by three ligaments:

- **The Acromio-clavicular ligament** which attaches the clavicle to the acromion of the scapula. (Figure 1)

- **Superior Acromio-clavicular Ligament**. This ligament is a quadrilateral band, covering the superior part of the articulation, and extending between the upper part of the lateral end of the clavicle and the adjoining part of the upper surface of the
acromion. It is composed of parallel fibers, which interlace with the aponeurosis of the Trapezius and Deltoid; below, it is in contact with the articular disk when this is present.

- **Inferior Acromio-clavicular Ligament** - This ligament is somewhat thinner than the preceding; it covers the under part of the articulation, and is attached to the adjoining surfaces of the two bones. It is in relation, above, in rare cases with the articular disk; below, with the tendon of the Supraspinatus.

  a) The Coraco-acromial ligament which runs from the coracoid process to the acromion.(Figure 1). The coraco-acromial Ligament is a strong triangular band, extending between the coracoid process and the acromion. It is attached, by its apex, to the summit of the acromion just in front of the articular surface for the clavicle; and by its broad base to the whole length of the lateral border of the coracoid process. This ligament, together with the coracoid process and the acromion, forms a vault for the protection of the head of the humerus.(Figure 2) It is in relation, above, with the clavicle and under surface of the Deltoid; below, with the tendon of the Supraspinatus, a bursa being interposed. Its lateral border is continuous with a dense lamina that passes beneath the Deltoid upon the tendons of the Supraspinatus and Infraspinatus. The ligament is sometimes described as consisting of two marginal bands and a thinner intervening portion, the two bands being attached respectively to the apex and the base of the coracoid process, and joining together at the acromion 35.

  b) The Coracoclavicular Ligament serves to connect the clavicle with the coracoid process of the scapula.

  (Figure 3) It does not properly belong to the acromioclavicular joint articulation, but is usually described with it, since it forms a most efficient means of retaining
the clavicle in contact with the acromion. It consists of two fasciculi, called the trapezoid ligament and conoid ligament.

These ligaments are in relation, in front, with the Subclavius and Deltoideus; behind, with the Trapezius.\textsuperscript{35}

\textbf{FIGURE 2 – LATERAL VIEW OF SHOULD GIRDLE SHOWING THE RELATION OF CLAVICLE TO CORACOID PROCESS AND DIRECTION OF THE CORACO-CLAVICULAR LIGAMENT.}
FIGURE 3 – THE CORACOCLAVICULAR LIGAMENT AND CORACO-CLAVICULAR LIGAMENT COMPLEX AND ITS CONTENTS.
Classification of Acromioclavicular Joint Dislocation

Rockwood Classification\textsuperscript{36}

**Type I** (Figure 4)
- 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** (Figure 5)
- Acromio-clavicular 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 Acromio-clavicular joint widening. Stress films show the coracoclavicular ligaments are sprained but integrity is maintained.
**Type III**: (Figure 6)

- Acromio-clavicular 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.\(^{36}\) The Acromio-clavicular 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**: (Figure 7)

- Type III with the distal clavicle displaced posteriorly into or through the trapezius.
- 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 (Figure 8)

- Type III with the distal clavicle grossly and severely displaced 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 (Figure 9)

- Acromio-clavicular joint 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.36
MATERIALS AND METHODS

This study is a Retrospective and prospective type of study.

Duration of study is from January 2009 to July 2011

For the Case selection criteria all patients, during this period, diagnosed with acute acromio-clavicular joint dislocation will be screened using the inclusion and exclusion criteria. Informed consent will be taken for all patients that fit the inclusion criteria and all patients willing to undergo the trial will be included.

Study method - All the patients will be followed up on 1st, 3rd, 6th and 1 year and 2 year and will be studied as per the UCLA score and Constant score.

All the patients were evaluated for difference in Range of motion at 6 weeks follow up and then each follow up at 3 months, 6 month, 1 year and 2 year using the Constant and UCLA Score. The evaluation of difference of Constant score and UCLA score and the progress was evaluated at 1st follow up and each follow up was done using a paired t-test. p value of < 0.05 was considered to be of significance. The Constant and UCLA score was not possible pre operatively as only acute acromio-clavicular injuries only. The effect of the type of dislocation and body mass index on the final functional outcome was also studied using the ANOVA test.
Inclusion criteria:

Acromio-clavicular joint dislocation Type III and above as per Rockwood classification. (69)

Exclusion criteria:

a. Patients with fracture lateral end of the clavicle.

b. Patients with chronic acromioclavicular dislocation.

c. Patients with Type 1 & Type 2 of acromioclavicular dislocation as per Rockwood classification.

d. Patients above 60 years of age

e. Patients with pain free AC joint dislocation and Full ROM after dislocation

TREATMENT PROTOCOL:

During the period between January 2009 and July 2011, all patients diagnosed with acute acromioclavicular joint dislocation seen were screened using the inclusion and exclusion criteria. Informed consent was taken for all patients that fit the inclusion criteria and all patients willing to undergo the trial were included.
INITIAL MANAGEMENT:

Clinical and radiological examination of all patients and primary resuscitation of all patients if required was done for all patients included in the trial following which treatment instituted included

- Temporary immobilization: - universal shoulder immobilizer or sling support.
- Analgesics and other symptomatic treatment

Preoperative planning:

1) X rays of the shoulder – Antero-posterior and Zanca View
2) Stress X rays with 5kilograms of weight
3) Pre-operative routine laboratory investigations

All the patients were classified according to the Rockwood classification for Acromio-clavicular joint injury.

Each patient underwent a set of investigations - Haemogram, Blood Sugar Level, Bleeding & Clotting Time, HBsAg, HIV, Blood Group, Urine – Routine & Microscopy, Chest Radiograph, and ECG. Other pre-operative and metabolic investigations for medical and anesthetic fitness were done. Patients were operated using donor tendon grafts and bio screw, k wire or twin fix sutures . Operative procedure was documented in terms of operative time, size of screws, twinfix sutures anchors for anchoring the grafts.
Operative Procedure:

The total number of patients involved was divided into two groups – Group A and Group B. Group A were operated with reconstruction of the coraco–clavicular ligament using donor graft and temporary stabilization of the acromio-clavicular joint with K wire (1 week). Group B patients were operated with reconstruction of the coraco–clavicular ligament as well as the acromio-clavicular joint was secured using donor graft and the knot secured using twinfix anchor sutures (Modified Procedure). This procedure did not require the acromio-clavicular joint to be stabilized with K wire.

**Group A** - Under general anesthesia, under all aseptic condition, with patient in supine position, a coronal incision is made over the outer one inch of the clavicle, and extended laterally over the acromion process and the attachment of the deltoid muscle to its outer side. Coracoid process is exposed

Assessment of the Acromio-clavicular joint ligaments was done (Figure 10)

![FIGURE 10](image)
Graft is harvested preferably from the ipsilateral lower limb under tourniquet. (Figure 11). We used semitendinosus muscle in all our cases.

![Figure 11](image11.jpg)

Graft is ultrabraid railroaded and tensioning and preparation of the graft is done. Graft passed around coracoid process.

A tunnel of approximately 5 mm is made in the lateral end clavicle around 50 mm medial from the acromion-clavicular joint (Figure 12) through which the graft is passed and fixed with bio screw of appropriate size. (Figure 13)

![Figure 12](image12.jpg)

![Figure 13](image13.jpg)

Graft is kept under tension so as to stabilize the acromio-clavicular joint.
K wires passed across acromio-clavicular joint.

Closure was done in layers.

**Group B-** In Beach chair position, under general anesthesia. Sabre incision taken. Acromio-clavicular joint exposed. Acromio-clavicular joint dislocation confirmed. Lateral end clavicle excised. Graft was taken from ipsilateral lower limb under tourniquet. Graft and ultrabraid railroaded. Coracoid process was exposed through deltoid split approach. Deltoid insertion was preserved. Graft looped around coracoid. The graft is then looped around the Acromio-clavicular joint (Figure 13) and knot tied above clavicle. Knot was reinforced with twin fix 2.8 mm suture anchor. Acromio-clavicular joint capsule repair was done. Wash was given and closure done in layers.
**Post operative protocol:** The arm is held in universal immobilizer or chest arm strapping was given (Figure 14).

![Image of immobilizer](image)

**FIGURE 14**

**Physiotherapy Protocol:**

First 2 weeks arm in universal shoulder immobilizer with movement of the elbow

3rd and 4th week- Uniplanar flexion, abduction, extension and flexion exercises of the shoulder in scaption position.

5th and 6th week- Up-to 90° flexion and abduction of the shoulder i.e Biplanar motion exercises were given.

For next 3 to 4 months - full shoulder range of motion exercises was advised.

Since, the range of motion could not be evaluated pre-operatively patient being having acute injuries. The difference between pre-operative and post-operative range of motion could not be analyzed.
OUTCOMES AND ANALYSIS

In the study period we had 22 patients who suffered from acromio-clavicular joint dislocation of which 18 patients were treated with reconstruction of acromio-clavicular joint with donor graft and included in the study group after screening through the inclusion and exclusion criteria. There was no death during the study period. One patient lost follow up from 3 months post surgery and 2 patients did not complete 2 years for final follow up. Finally 15 patients were available for 2 years follow up and were included in the study population with follow up of 6 weeks, 3 months, 6 months, 1 year and 2 year.

LATERALITY

In our study side of injury was almost equally distributed. Table 1 gives the distribution of the injury side amongst the patient between rights being 8 and left were 7.

<table>
<thead>
<tr>
<th>Side</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>8</td>
</tr>
<tr>
<td>Left</td>
<td>7</td>
</tr>
</tbody>
</table>
GRAPH 1 – DISTRIBUTION OF SIDE

**Conclusion** - Graph 1 denotes that there is no particular co-relation in the injury pattern and the side of the upper limb involved.

**AGE DISTRIBUTION** – Patients age ranged from 24 to 59 at presentation with a mean ± SD of 38.4 ±11.160 years of age. Table 2 gives the distribution of age of the patients involved in the study. Highest number of patients was in the age group of 20-30 years with 33.33% of patients in that particular group.
## Table 2

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Number of patients</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 -29</td>
<td>5</td>
<td>33.33</td>
</tr>
<tr>
<td>30-39</td>
<td>4</td>
<td>26.66</td>
</tr>
<tr>
<td>40-49</td>
<td>2</td>
<td>13.33</td>
</tr>
<tr>
<td>50-59</td>
<td>4</td>
<td>26.66</td>
</tr>
</tbody>
</table>

## Graph 2

**AGE DISTRIBUTION**

### GRAPH 2 – DISTRIBUTION OF AGE

**Conclusion** – Graph 2 shows that there is a majority of subjects in the age group of 20 - 30 years of age denoting that this kind of injury in more common in younger age group. Least incidence is in the age group in 40 – 50 years of age group.
Sex distribution, out of 15 only 13 were males having a majority of almost 86.66% compared to 2 females making upto 13.33% only as shown in table 3

Table 3

<table>
<thead>
<tr>
<th>Sex</th>
<th>Number of patients</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>Male</td>
<td>13</td>
<td>86.66</td>
</tr>
<tr>
<td>Female</td>
<td>2</td>
<td>13.33</td>
</tr>
</tbody>
</table>

Graph 3

GRAPH 3 – SEX DISTRIBUTION

Conclusion - The above figures and graphical representation in graph 2 shows that there is a clear preponderance of males over such kind of injury.
**MODE OF INJURY –**

The mechanism of injury majorly was road traffic accident i.e 9 out of 15 patients reported a fall on shoulder while travelling a 2 wheeler. The other causes were slip and fall in 4 and sporting injury to shoulder in 2 i.e. 13.33 %

<table>
<thead>
<tr>
<th>Mode of injury</th>
<th>Number of patient</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTA</td>
<td>9</td>
<td>60</td>
</tr>
<tr>
<td>Slip and fall</td>
<td>4</td>
<td>26.66</td>
</tr>
<tr>
<td>Sports injury</td>
<td>2</td>
<td>13.33</td>
</tr>
</tbody>
</table>

**Graph 4**

GRAPH 4 – DISTRIBUTION OF MODE OF INJURY FOR ACROMIO CLAVICULAR DISLOCATION.
**Conclusion** - Our study had Road traffic accident as the major cause with almost 60% of patients having it as a cause for such kind of injury as shown in Graph 4. with sports injury having minimum amount of such injury having only 2 patients.

**CONSTANT AND UCLA SCORING SYSTEM** –

All patient were assessed using the Constant and UCLA scoring system. Following is the table showing the average improvement of the Constant score over 2 years. The Mean constant score at 6 weeks follow up was 37.06 and it went up to 91.86 in the final follow up of 2 years. P value of 0.0069 in table 5 shows that the improvement in the constant scoring is significant at 2 years follow up compared to the first follow up.

<table>
<thead>
<tr>
<th>Follow up</th>
<th>Average Constant score</th>
<th>Standard deviation</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 weeks</td>
<td>37.06</td>
<td>1.163</td>
<td>-</td>
</tr>
<tr>
<td>3 months</td>
<td>71.8</td>
<td>1.082</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>6 months</td>
<td>89.53</td>
<td>2.800</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>1 year</td>
<td>90.93</td>
<td>2.939</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>2 year</td>
<td>91.86</td>
<td>2.356</td>
<td>0.0069</td>
</tr>
</tbody>
</table>
Graph 5

Average constant score

<table>
<thead>
<tr>
<th>Time</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 weeks</td>
<td>37.06</td>
</tr>
<tr>
<td>3 months</td>
<td>71.8</td>
</tr>
<tr>
<td>6 months</td>
<td>89.53</td>
</tr>
<tr>
<td>1 year</td>
<td>90.93</td>
</tr>
<tr>
<td>2 year</td>
<td>91.86</td>
</tr>
</tbody>
</table>

**Graph 5 – Average of Constant Score and Improvement for Each Follow Up.**

**Conclusion** - As seen from the observation the Constant score improved over the period of observation and is significant according to the paired t-test with P value being <0.001 on every follow up. Graph 5 shows the average improvement in the function in terms of constant scoring over years of follow up.

Table 6 shows result of function in term of UCLA score with the mean being 7.06 and standard deviation of 0.59 at first follow up of 6 weeks. The final follow up of 2 years shows a significant improvement in function with mean of 31.66.
Table 6

<table>
<thead>
<tr>
<th>Follow up</th>
<th>Average UCLA score</th>
<th>Standard deviation</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 weeks</td>
<td>7.06</td>
<td>0.59</td>
<td>-</td>
</tr>
<tr>
<td>3 months</td>
<td>19.6</td>
<td>0.9103</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>6 months</td>
<td>29.4</td>
<td>1.549</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>1 year</td>
<td>30.86</td>
<td>1.846</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>2 year</td>
<td>31.66</td>
<td>1.234</td>
<td>0.0009</td>
</tr>
</tbody>
</table>

Graph 6

Average UCLA score

GRAPH 6 – AVERAGE OF UCLA SCORES AT EACH FOLLOW UP
**Conclusion** - The UCLA score improved significantly as seen by the graphical presentation in graph 6. The P value at follow up of 2 years shows that average improvement in the Constant score over 2 years is significant according to the paired t test.

The mean time to achieve painless full abduction was 6 months (range 5 – 8 months). The mean time reported for return to full recreational activity was 3.5 months (range 2-6 months).

**COMPARISON OF THE NORMAL AND AFFECTED ARM (FINAL FOLLOW UP)**

We made a comparison of the UCLA and Constant score of the affected arm at 2 years follow up and the normal arm. Table 7 shows the mean Constant score of normal arm being 97.4 and affected arm at 2 year follow up being 92.73. Similarly the UCLA score of affected arm at 2 years follow up was 32.53 with the normal arm being 34.93.

<table>
<thead>
<tr>
<th></th>
<th>NORMAL ARM</th>
<th>AFFECTED ARM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MEAN±SD</td>
<td>MEAN±SD</td>
</tr>
<tr>
<td>AVERAGE CONSTANT</td>
<td>97.4±0.83</td>
<td>92.73±1.83</td>
</tr>
<tr>
<td>AVERAGE UCLA</td>
<td>34.93±0.2582</td>
<td>32.53±0.74</td>
</tr>
</tbody>
</table>

Table 7
COMPARISON OF CONSTANT AND UCLA OF THE NORMAL ARM WITH THE FINAL POST OP FOLLOW UP (2ND YEAR FOLLOW UP)

**Conclusion** - Graphical representation in graph 7 shows the improvement of the affected arm and the normal arm in terms of the scores was excellent with the affected arm having average constant score of 92.73 and Average UCLA score of 32.53 at 2 years of follow up.

**Grading the Constant Shoulder Score**<sup>(74)</sup>
(Difference between normal and Abnormal Side)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td>&gt;30</td>
</tr>
<tr>
<td>Good</td>
<td>21-30</td>
</tr>
<tr>
<td>Fair</td>
<td>11-20</td>
</tr>
<tr>
<td>Very Good</td>
<td>6-10</td>
</tr>
<tr>
<td>Excellent</td>
<td>&lt;11</td>
</tr>
</tbody>
</table>
**Conclusion** - According to the above Grading of the constant score there was an excellent result in 13 of the patients in whom the difference in the Constant score between the affected and healthy shoulder was five or less in seven patients. Four had a very good result with a difference between the affected shoulder and healthy shoulder of between six and ten; two had a good result with a difference of between 11 and 20.

**Comparison of CC ligament reconstruction VS the Modified method** -

From our study we are also able to compare the results between the purely Coracoclavicular joint reconstruction and Temporary acromion-clavicular joint stabilization with K wire (Group A) and the other *Modified method* in which even the acromion-clavicular joint was tensioned and reconstructed with the graft (Group B). There were 5 patients in Group A and 10 patients with Group B. After doing purely CC ligament reconstruction and stabilizing the acromion-clavicular joint with K wire the clavicle got translated anteriorly coracoid process being lying anterior to the clavicle. Hence the procedure was modified and the acromio-clavicular joint was reconstructed with a loop of donor graft.

The average of Constant score at 2 year follow up of patients in Group A was 89.8.

The average of Constant score of group B was 92.9 as in Table 8.
Table 8

<table>
<thead>
<tr>
<th>Group</th>
<th>Average Constant score</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>89.8</td>
</tr>
<tr>
<td>B</td>
<td>92.9</td>
</tr>
</tbody>
</table>

Graph 8

CONSTANT SCORE IN GROUP AND GROUP B AT 2 YEAS FOLLOW UP.

Conclusion - The above comparison in graph 8 shows that the net result in Group B with mean of constant score of 92.9 at follow up of 2 years and standard deviation of 2.92 was better at 2 year of follow up with Group B having mean constant score of 89.8 at 2 year follow up and standard deviation of 0.4472
Using the unpaired t-test he two-tailed P value is 0.0099, considered very significant. Shows that there is a significant difference in the result, with better results is using the Modified method with a Loop of graft around acromion-clavicular joint over the standard method using Temporary K wire for acromion-clavicular joint stabilization.

*Effect of type of dislocation on Functional outcome –*

We made a comparison of the functional outcome of our 15 subjects in terms of type of dislocation using the constant score. According to Table 9 shows there are 8 patients of Rockwood Type III dislocation with mean constant score of 91.5 ± 2 standard deviation. Similarly there 5 and 2 patients in Type IV and Type V respectively with mean of 91.6 ± 3.05 standard deviation and 94 ± 1.414 standard deviation respectively.

The P value was found to be 0.4175.

<table>
<thead>
<tr>
<th>Rockwood dislocation Type</th>
<th>Number of patients</th>
<th>Constant score (Mean ± SD)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>III</td>
<td>8</td>
<td>91.5 ± 2</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>5</td>
<td>91.6 ± 3.05</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>2</td>
<td>94 ± 1.414</td>
<td>0.4175</td>
</tr>
</tbody>
</table>
**Conclusion** - Using the ANOVA test the $P$ value is 0.4175, which is considered not significant. Hence the variation among means is not significantly greater than expected by chance. This shows that there is not much significance in 2 year follow up Constant score with respect to the type of acromio-clavicular dislocation.

*Effect of BMI on Functional outcome –*

We made a comparison of functional outcome of our 15 patients in terms of Body mass index. Comparison we divided our patients into those having BMI less than 20, 20 – 25 and more than 25. There are 2 patients in BMI < 20 with mean Constant score of 91.5 and standard deviation of 2.121. Similarly there are 9 and 4 patients in 20 - 25 and > 25 group respectively. They have mean Constant score and standard deviation of $92.11 \pm 2.759$ and $91.5 \pm 1.915$ respectively.
Table 10

<table>
<thead>
<tr>
<th>Body mass index</th>
<th>Number of patients</th>
<th>Constant score (Mean ± SD)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20</td>
<td>2</td>
<td>91.5 ± 2.121</td>
<td></td>
</tr>
<tr>
<td>20 – 25</td>
<td>9</td>
<td>92.11 ± 2.759</td>
<td></td>
</tr>
<tr>
<td>&gt;25</td>
<td>4</td>
<td>91.5 ± 1.915</td>
<td>0.9010</td>
</tr>
</tbody>
</table>

Graph 10

GRAPH 9 - MEAN CONSTANT SCORE WITH RESPECT TO ROCKWOODS TYPE OF DISLOCATION

There was no case of infection recorded. Not a single case of K wire back out noted.
There were no cases of proximal migration. No case fracture of lateral end of clavicle and re-dislocation or graft breakage.
There was one case that had residual subluxation of Acromio-clavicular joint with prominence of the clavicle, but functionally the patient had results as comparable to the mean and patient had full range of motion with minimal difficulties in doing heavy activities. There was no donor site morbidity with the patients having range of motion of the donor knee joint being on an average being 0 -110 degrees.
CASES

Case 1 (Group A)
24 years male. A case of Type 3 Acromio-clavicular dislocation operated with Reconstruction of Coraco clavicular joint reconstruction with donor graft and temporary stabilization of AC joint with K wire

(a) Pre op X-ray          (b) Post op X-ray

Figure (c) 2 year Post op.       (d) Range of Abduction at 2 years       (e) Range of Flexion at 2 years

(f) Internal Rotation at 2 years       (g) External Rotation at 2 years
Case 2 – (Group B) 50 years male. Type 3 Acromio clavicular dislocation, operated with Reconstruction of the Coraco clavicular ligaments and Accromio clavicular joint with Donor graft and twin fix.

(a) Pre op X-ray  
(b) Post op X-ray

Figure (c) 2years Post op.  
d) Range of Abduction at 2 years  
e) Range of int rotation at 2 years

f) Range of ext rotation at 2 years  
g) Range of extension at 2 years
DISCUSSION

The Main function of the AC joint and its ligament is includes suspension of the scapula and support of the weight of the upper extremity. Once the ligaments get injured and damaged, the joint stability must be maintained by muscles. The deltoid and trapezius muscles are primarily involved in the acromio-clavicular stabilization when the ligaments are injured. The loss of suspension may lead to muscle fatigue, encroachment of the acromion on the supraspinatus tendon, and neurologic symptoms due to traction on the brachial plexus. Regardless of the type of the treatment, some patients will have various degrees of disability from the damage of the normal AC joint anatomy. Our rationale for operation is that reconstruction of the AC joint with tendon graft give chance to obtain normal shoulder function by restoring the normal anatomy. In April 15, 2010 Gregory Waryasz in a comparative study showed primary AC joint fixation, dynamic muscle transfers of the biceps and clavicle hook plate placement have higher complication and failure rates. Acromio-clavicular joint instability—reconstruction indications and techniques Brent A, Ponce, MD showed suture materials used in the primary fixation being a potential nidus of infection and higher infection rates in them. Hence in this study survey was done to see the functional outcome of the AC joint dislocation reconstructed with a tendon graft in patients over a mean period of 3 years. All the cases presented as acute cases and were treated with the above procedure and follow up revealed excellent functional outcome in more than 90% post operative findings do prove that operative treatment is the treatment of choice in AC joint dislocation of Type III and above.

Still acute treatment of grade III of AC joint injuries remains a controversial topic in the orthopedic literature. Grade III injuries continue to be subject of debate. Bathis Et al analyzed the literature systematically regarding the therapy of grade III AC joint
separation. In the high evidence papers analyzed its found the major outcome for both operative and non operative treatment have similar results. Advantages of non operative treatment is shorter period of rehabilitation and a lower complication rate, while advantages of operative treatment is lesser chances of persistent subluxation if the AC joint. However, studies prove non operative treatment of chronic AC joint instability has poorer outcome\textsuperscript{46}. Krueger-Frankee et al\textsuperscript{79} looked at AC joint separation as sports injuries and found that out 21 athletes undergoing AC joint repair operatively almost 86\% of the patients had functional outcome almost close to the pre operative function. They recommend operative treatment for AC joint dislocation. This supports our observation as can be seen that most of our patients were active males pre operatively and showed good functional results following surgery for grade III dislocation with no significant long term sequel.

Tauber M Et al\textsuperscript{32} had undertaken a cohort biomechanical study comparing various surgical techniques for Acromio-clavicular joint reconstruction have reported that semitendinosus tendon graft for C-C ligament reconstruction provides a substantial improvement in initial stability and the load-to-failure equivalent to the intact C-C ligaments. In this study 12 patients, operated with modified Weaver-dunn procedure and in other 12 patients autogenous semitendinosus tendon graft was used. The mean follow up was 37 months. Results showed the semitendinosus tendon group were significantly better than the Weaver-Dunn group (P < 0.001) . The radiological measurements under stress too showed better results in the semitendinosus tendon group. The difference during stress loading was statically significant (P < 0.027). In the semitendinosus tendon group, horizontal displacement of the lateral clavicle end could be reduced in all cases above type III dislocation. Similarly our study also proves a good outcome proving the use
of a tendon graft as a better method as most of our cases we have used semitendinosus
graft showing a significantly good functional and radiological outcome.

Mazzocca et al has been performing anatomic reconstructions of the coracoclavicular
ligaments using either semitendinosus or gracilis auto- or allograft tissue. The graft is
either looped under the coracoid or is fixed into it using a 5.5-mm interference screw. By
performing anatomic dissections and examining the osteology of the clavicle, Dr.
Mazzocca has determined that the conoid is a posterior structure and is, on average, 46
mm medial from the end of the clavicle. The conoid tubercle is an average of 25 mm from
the midpoint of the trapezoid line. Therefore, his anatomic reconstruction is aimed at
placing one limb of the graft posteriorly to reconstruct the conoid, whereas another limb of
the graft is placed anteriorly to reconstruct the trapezoid ligament. Bone tunnels are
drilled in a vertical direction and the graft limbs are passed through the clavicle at these
determined positions. The graft limbs are then secured using 5.5-mm interference screws.
Biomechanical testing of this repair construct has shown that there is significant decrease
in anterior and posterior displacement in comparison to a modified Weaver-Dunn
reconstruction, but that there is no significant difference in superior displacement.
Mazzocca et al reported on 12 patients (2 revisions), 4 with more than 2 years of follow-
up and 6 with more than 6 months of follow-up without any failures.

Stephen J Nicholas et al did a case series of 9 patients doing a C-C ligament
reconstruction using augmented semitendinosus allograft after a grade V dislocation.
Outcome of the study showed excellent results with full recovery of strength, minimal
loss of range of motion and no clinical and radiological loss of reduction of the AC joint.
Paul W Grutter et al compared modified Weaver dunn procedure with anatomical
reconstruction using a Palmaris longus graft and flexor carpi radialis graft and concluded
that tendon graft recreates the tensile strength of the native AC joint complex and is
superior to a modified Weaver dunn procedure. So does our study show with majority of the patients showing range of motion almost equal to the pre operative range or range equivalent to the opposite non injured AC joint proving this technique as a excellent method of treating AC joint dislocation above grade III. Thomas Quin et al had made a prospective study of Reconstruction of AC joint using LARS ligament (polyethylene tereothalate material) proving it to be a viable technique for surgical reconstruction of AC joint dislocation. Chun yan jian et al used a proximal based conjoined tendon transfer for coracoclavicular reconstruction in treatment of AC joint dislocation.

<table>
<thead>
<tr>
<th>Studies</th>
<th>Average 2 year follow up Constant score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thomas Quin ( LARS)</td>
<td>84.45</td>
</tr>
<tr>
<td>Chunyan Jiang(proximal tendon transfer)</td>
<td>90.6</td>
</tr>
<tr>
<td>Our Study (Semitendinosus graft)</td>
<td>92.8</td>
</tr>
<tr>
<td>Tauber M (Semitendinosus graft)</td>
<td>93</td>
</tr>
</tbody>
</table>

Average Constant score

- Tauber M: 93
- Our study: 92.8
- Chunyan: 90.6
- Thomas QUIN: 84.45

Average Constant score
Above graphical presentation proving that use of ligament for reconstruction of AC joint reconstruction having better results

In our study the complication rate was comparably low at a level of less than 10%. Other surgical correction techniques like hook plates or tension band wiring are associated with an early complication rate 42-58%\textsuperscript{45,46,49}. Complication such as breakage of wires or migration of K wires are possible. In a mean period of 3.5 months the reviewed patients returned to their pre traumatic recreation and after a mean time period of 6 months the patient returned to full work and function. Acromio-clavicular joint instability—reconstruction indications and techniques Brent A, Ponce, MD mentions regarding coracoclavicular ligament reconstruction techniques, removing the distal clavicle at the time of coracoclavicular ligament reconstruction is generally favored because of higher rates of acromioclavicular joint arthrosis with distal clavicle preservation\textsuperscript{70}.

From our study we could also compare the results between two methods of Reconstruction of Acromio-clavicular dislocation where in group we had 5 patients with Reconstruction of only coracoclavicular ligament done with graft and temporary fixation of the Acromio-clavicular joint with K wires done and the other group had 10 patients were operated with the modified method where the acromio-clavicular joint and coracoclavicular ligaments both were reconstructed using the single graft.

And our study revealed that the Modified methods had better results in terms of mean of Constant score at 2 years follow. However according the Grading of the Constant score—even the first method showed excellent to very good results.

No scars are seen in the non operative treatment but then the deformity remains persistently visible due to absence of anatomical reduction. Recently some authors proposed arthroscopic stabilization of acromion-clavicular joint separation to avoid the
disadvantage of an open surgery. The clinical experience of this technique is still being
developed\textsuperscript{50}.

In our procedure there is a donor site, preferably the same side of the limb, but we did not
record any donor site morbidity either intra operatively or during follow up. In this study we
studied only the operative cases of AC joint dislocation were taken there was no
randomization done according to the non operative and operative group. The sample size
was also small with only 15 patients included in our study. These are the limitations of our
study.

In a comparative study done by Mathias Wellmann et al\textsuperscript{5} made a study of of anatomical
coracoclavicular ligament repairs using autologous tendon graft versus synthetic suture
augmentation. Debate is that optimum fixation strategies in both the case are not solved.
The study included biomechanical testing including cyclical supero-inferior loading and
subsequent load to failure studies. The ultimate failure loads were significantly higher for
the synthetic suture segmentation using polyester flip button repair (927N) compared to
all tendon repair techniques (640 N). Hence polyester suture provided adequate structural
properties compared to tendon graft and tendon graft should be opted by the necessity of
a biologic substrate rather than by the assumption of a biomechanical advantage. This is
one point where the advantages of other method is proved better than reconstruction
however flip button repair had higher incidence of complication of clavicle fractures which
is nil in our method.
CONCLUSION

1) We thus conclude that the Acromio-clavicular reconstruction with Donor graft for complete AC joint separation can effectively be used and has good to excellent results and functional outcome.

2) It is associated with a high patient contentedness and low complication rate. This surgical technique can therefore be used for repair of Acromio-clavicular joint dislocation Rockwood type III and above.

3) Reconstruction of the acromion-clavicular joint with donor graft along with coraco-clavicular ligaments has better outcome as compared to temporary stabilization of the acromio-clavicular joint with K wire.
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ANNEXURES:

ANNEXURE A – Proforma of evaluation.

Post operative follow up at 6 weeks, 3 months, 6 months, 1 year, 1 ½ year, 2 year

PATIENT EVALUATION - PROFORMA

Case No.: - ________.

Name: - _________________________________________.

Age: - ______ yrs.   Sex: - _________.        Reg. No: - ________________.

Address: - _____________________________________________________________________.

Habits: - _________________________________________.

Diagnosis and side: -

__________________________________________________________________________

Type of Dislocation:-________________________________________________________________

Date of Injury: - ________________ Mode of injury: - __________________________.

Date of Admission: - ________________ Hand Dominance: - ________________.

Date of Surgery: - ________________.

Date of Discharge: - ________________.

Trauma- Surgery Interval: - ________________.

Clinical assessment /BMI: - ______________________
Symptoms –

VAS score: -___________________

Duration of pain: - ______________

Other complaints: - _______________

Pre Op – Flexion: - _____ Extension: - ___________ Abduction: - ___________

Rotations: - __________

Post op – Follow up – 6 weeks, 3 months, 6 months, 1 year, 2 years.

Flexion:- _____ Extension :- ______________ Abduction :- _____________

Rotations:- ___________ Constant Score :-___________ UCLA score:-__________

At 2 year follow up – Opposite shoulder

Flexion:- _____ Extension :- ______________ Abduction :- _____________

Rotations:- ________ Constant Score :-____________ UCLA score:-____________

Donor Knee

Flexion:-_________ Extension:_________


# ANNEXURE B - UNIVERSITY OF CALIFORNIA, LOS ANGELES (UCLA) SCORES

## PAIN

<table>
<thead>
<tr>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present always &amp; unbearable. Strong medicine</td>
<td>1</td>
</tr>
<tr>
<td>Present always but bearable. Occasional medicine</td>
<td>2</td>
</tr>
<tr>
<td>No pain at rest/only on light activities</td>
<td>4</td>
</tr>
<tr>
<td>Pain on heavy activates only</td>
<td>6</td>
</tr>
<tr>
<td>Occasional and slight</td>
<td>8</td>
</tr>
<tr>
<td>No pain</td>
<td>10</td>
</tr>
</tbody>
</table>

## Function

<table>
<thead>
<tr>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unable to use limb</td>
<td>1</td>
</tr>
<tr>
<td>Only light activities possible</td>
<td>2</td>
</tr>
<tr>
<td>Light house work</td>
<td>4</td>
</tr>
<tr>
<td>Driving, shopping, dress &amp; undress hair possible</td>
<td>6</td>
</tr>
<tr>
<td>Work above shoulder level-slight restriction only</td>
<td>8</td>
</tr>
<tr>
<td>Normal activities</td>
<td>10</td>
</tr>
</tbody>
</table>

## Active forward flexion

<table>
<thead>
<tr>
<th>Degree</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;150</td>
<td>5</td>
</tr>
<tr>
<td>120-150</td>
<td>4</td>
</tr>
<tr>
<td>90-120</td>
<td>3</td>
</tr>
<tr>
<td>45-90</td>
<td>2</td>
</tr>
<tr>
<td>30-45</td>
<td>1</td>
</tr>
<tr>
<td>&lt;30</td>
<td>0</td>
</tr>
</tbody>
</table>

## Strength of FF

<table>
<thead>
<tr>
<th>Grade</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 5</td>
<td>5</td>
</tr>
<tr>
<td>Grade 4</td>
<td>4</td>
</tr>
<tr>
<td>Grade 3</td>
<td>3</td>
</tr>
<tr>
<td>Grade 2</td>
<td>2</td>
</tr>
<tr>
<td>Grade 1</td>
<td>1</td>
</tr>
<tr>
<td>Grade 0</td>
<td>0</td>
</tr>
</tbody>
</table>

## Satisfaction of patient

<table>
<thead>
<tr>
<th>Satisfaction</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfied and better</td>
<td>5</td>
</tr>
<tr>
<td>Not satisfied</td>
<td>0</td>
</tr>
</tbody>
</table>

| **TOTAL**   | 35    |
Constant Score Technique

BACKGROUND

The European Society for Shoulder and Elbow Surgery (ESSES) adopted the scoring system of Constant and Murley

This scoring system consists of four variables that are used to assess the function of the shoulder. The right and left shoulders are assessed separately. The subjective variables are pain and ADL (sleep, work, recreation / sport) which give a total of 35 points.

The objective variables are range of motion and strength which give a total of 65 points.

<table>
<thead>
<tr>
<th>SUBJECTIVE</th>
<th></th>
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<tbody>
<tr>
<td>Pain</td>
<td>15</td>
</tr>
<tr>
<td>ADL (sleep, work, recreation/sport)</td>
<td>20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OBJECTIVE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Range of motion</td>
<td>40</td>
</tr>
<tr>
<td>Strength</td>
<td>25</td>
</tr>
</tbody>
</table>

RANGE OF MOTION

Active range of motion should always be measured as part of the Constant Score.

ESSES recommends measuring range of motion with the patient sitting on a chair or bed, with weight even distributed between the ischial tuberosities. No rotation of the upper body may take place during the examination.

In the case of active motion, the patient lifts his arm to a pain-free level. Note that the number of degrees at which the pain starts determines the range of motion. If one measures the active range of motion with pain, this should be stated. The Constant score cannot then be applied beyond the initiation of pain.
The most important thing is that range of motion is performed and measured in a standardised way.

In the Constant score system there is precise information about how the points are calculated. Bear in mind that 150 degrees of flexion give 8 points, while 151 degrees give 10 points.

**CONSTANT FUNCTIONAL SCORE:-**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>6 wks</th>
<th>3 mths</th>
<th>6 mths</th>
<th>1 year</th>
<th>2 year</th>
<th>Final f/u</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pain</td>
<td></td>
<td></td>
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<tr>
<td>2. Activity Level</td>
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<td></td>
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<tr>
<td>3. Arm Positioning</td>
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<tr>
<td>4. Flexion</td>
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<tr>
<td>5. Abduction</td>
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<tr>
<td>6. External Rotation</td>
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<tr>
<td>7. Internal Rotation</td>
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<tr>
<td>8. Strength of Abduction</td>
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</tr>
<tr>
<td>Total score</td>
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</tr>
</tbody>
</table>

Strength is given a maximum of 25 points in the Constant Score. The significance and technique of strength measurement has been, and continues to be, the subject of much discussion.

The European Society for Shoulder and Elbow Surgery measures strength according to the following method:

- A spring balance is attached distal on the forearm.
• Strength is measured with the arm in 90 degrees of elevation in the plane of the scapula (30 degrees in front of the coronal plane) and elbow straight.

• Palm of the hand facing the floor (pronation).

• The patient is asked to maintain this resisted elevation for 5 seconds.

• It is repeated 3 times immediately after another.

• The average in pound (lb) is noted.

• The measurement should be pain-free. If pain is involved the patient gets 0 points.

• If patient is unable to achieve 90 degrees of elevation in the scapula plane the patient gets 0 points.

ANNEXURE D:-

Grading the Constant Shoulder Score\textsuperscript{(74)}

(Difference between normal and Abnormal Side)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Score Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td>&gt;30</td>
</tr>
<tr>
<td>Good</td>
<td>21-30</td>
</tr>
<tr>
<td>Fair</td>
<td>11-20</td>
</tr>
<tr>
<td>Very Good</td>
<td>6-10</td>
</tr>
<tr>
<td>Excellent</td>
<td>&lt;11</td>
</tr>
</tbody>
</table>