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CLINICAL OUTCOMES OF ANTERIOR BRIDGE PLATING FOR HUMERUS SHAFT FRACTURES BY MINIMAL INVASIVE TECHNIQUE

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Abstract:

Near normal acceptable reduction and rigid stable fixation has its biological advantage as compare to absolute anatomical reduction with compromising soft tissue and vascularity. Biological fixation of fractures with soft tissue preservation and near acceptable reduction is becoming a more acceptable entity. However it is to be evaluated. For a satisfactorily outcome only union is not the only requirement but early and acceptable functional usage of the limb is the goal. Therefore concept of biological fixation was developed over a stable mechanical fixation. This has evolved the development and improvement in the techniques of biological fracture fixation and stabilization systems. From conservative cast and braces to internal fixation with intramedullary interlocking nailing, ORIF with plate and screw. Treatment of humeral fracture has evolved a lot with their complications. Studies are still going on to prove superiority of one over another. Minimally invasive technique for humerus shaft fracture has shown promising results recently.

The present study was planned in Department of Orthopaedic, Sri Krishna Medical College and Hospital (SKMCH), Muzaffarpur, Bihar from jan 2017 to Oct 2017. Total 10 cases with fractures of humerus shaft were treated with Minimum invasive Anterior Bridge plating techniques were evaluated in the present study.

The data generated from the present study concludes that though the technique is very promising, it has a steep learning curve involved. The greatest advantage is minimally invasive, minimal soft tissue stripping, smaller incisions, minimal blood loss, shorter operative time and early rehabilitation. In conclusion anterior bridge plating (ABP) is very good technique in treating midshaft humeral fractures with minimal soft tissue dissection, smaller scars, and early return to overhead activities.

Keywords: Anterior bridge plate, humerus fracture, minimal invasive technique, minimal invasive procedure, etc.

Introduction

A humerus fracture is a break of the humerus bone in the upper arm. Symptoms may include pain, swelling, and bruising. There may be a decreased ability to move the arm and the person may present holding their elbow. Complications may include injury to an artery or nerve, and compartment syndrome. The cause of a humerus fracture is usually physical trauma such as a fall. Other causes include conditions such as cancer in the bone. Types include proximal humeral fractures, humeral shaft fractures, and distal humeral fractures. Diagnosis is generally confirmed by X-rays. A CT scan may be done in proximal fractures to gather further details. Treatment options may include a sling, splint, brace, or surgery. In proximal fractures that remain well aligned, a sling is often sufficient. Many humerus shaft fractures may be treated with a brace rather than surgery. Surgical options may include open reduction and internal fixation, closed reduction and percutaneous pinning, and intramedullary nailing. Joint replacement may be another option. Proximal and shaft fractures generally have a good outcome while outcomes with distal fractures can be less good. They represent about 4% of fractures. [2]

After a humerus fracture, pain is immediate, enduring, and exacerbated with the slightest movements. The affected region swells, with bruising appearing a day or two after the fracture. The fracture is typically accompanied by a discoloration of the skin at the site of the fracture. A crackling or rattling sound may also be present, caused by the fractured humerus pressing against itself. In cases in which the nerves are affected, then there will be a loss of control or sensation in the arm below the fracture. If the fracture affects the blood supply, then the patient will have a diminished pulse at the wrist. Displaced fractures of the humerus shaft will often cause deformity and a shortening of the length of the upper arm. Distal fractures may also cause deformity, and they typically limit the ability to flex the elbow. [2]

Humerus fractures usually occur after physical trauma, falls, excess physical stress, or pathological conditions. Falls that produce humerus fractures among the elderly are usually accompanied by a preexisting risk factor for bone fracture, such as osteoporosis, a low bone density, or vitamin B deficiency.

Proximal humerus fractures most often occur among elderly people with osteoporosis who fall on an outstretched arm. Less frequently, proximal fractures occur from motor vehicle accidents, gunshots, and violent muscle contractions from an electric shock or seizure. Other risk factors for proximal fractures include having a low bone mineral density, having impaired vision and balance, and tobacco smoking. A stress fracture of the proximal and shaft regions can occur after an excessive amount of throwing, such as pitching in baseball. [3]

Middle fractures are usually caused by either physical trauma or falls. Physical trauma to the humerus shaft tends to produce transverse fractures whereas falls tend to produce spiral fractures. Metastatic breast cancer may also cause fractures in the humerus shaft. Long spiral fractures of the shaft that are present in children may indicate physical abuse.

Distal humerus fractures usually occur as a result of physical trauma to the elbow region. If the elbow is bent during the trauma, then the olecranon is driven upward, producing a T- or Y-shaped fracture or displacing one of the condyles. [2]

Definitive diagnosis of humerus fractures is typically made through radiographic imaging. For proximal fractures, X-rays can be taken from a scapular anteroposterior (AP) view, which takes an image of the front of the shoulder region from an angle, a scapular Y view, which takes an image of the back of the shoulder region from an angle, and an axillar lateral view, which has the patient lie on his or her back, lift the bottom half of the arm up to the side, and have an image taken of the axilla region underneath the shoulder. Fractures of the humerus shaft are usually correctly identified with radiographic images taken from the AP and lateral viewpoints. Damage to the radial nerve from a shaft fracture can be identified by an inability to bend the hand backwards or by decreased sensation in the back of the hand. Images of the distal region are often of poor quality due to the patient being unable to extend the elbow because of pain. If a severe distal fracture is suspected, then a computed tomography (CT) scan can provide greater detail of the fracture. Nondisplaced distal fractures may not be directly visible; they may only be visible due to fat being displaced because of internal bleeding in the elbow. [2]

Fractures of the humerus are classified based on the location of the fracture and then by the type of fracture. There are three locations that humerus fractures occur: at the proximal location, which is the top of the humerus near the shoulder, in the middle, which is at the shaft of the humerus, and the distal location, which is the bottom of the humerus near the elbow. Proximal fractures are classified into one of four types of fractures based on the displacement of the greater tubercle, the lesser tubercle, the surgical neck, and the anatomical neck, which are the four parts of the proximal humerus, with fracture displacement being defined as at least one centimeter of separation or an angulation greater than 45 degrees. One-part fractures involve no displacement of any parts of the humerus, two-part fractures have one part displaced relative to the other three; three-part fractures have two displaced fragments, and four-part fractures have all fragments displaced from each other. Fractures of the humerus shaft are subdivided into transverse fractures, spiral fractures, "butterfly" fractures, which are a combination of transverse and spiral fractures, and pathological fractures, which are fractures caused by medical conditions. Distal fractures are split between supracondylar fractures, which are transverse fractures above the two condyles at the bottom of the humerus, and intercondylar fractures, which involve a T- or Y-shaped fracture that splits the condyles. [2]

Humerus fractures are among the most common of fractures. Proximal fractures make up 5% of all fractures and 25% of humerus fractures, middle fractures about 60% of humerus fractures (12% of all fractures), and distal fractures the remainder. Among proximal fractures, 80% are one-part, 10% are two-part, and the remaining 10% are three- and four-part. The most common location of proximal fractures is at the surgical neck of the humerus. Incidence of proximal fractures increases with age, with about 75% of cases occurring among people over the age of 60. In this age group, about three times as many women than men experience a proximal fracture. Middle fractures are also common among the elderly, but they frequently occur among physically active young adult men who experience physical trauma to the humerus. Distal fractures are rare among adults, occurring primarily in children who experience physical trauma to the elbow region. [3]

Near normal acceptable reduction and rigid stable fixation has its biological advantage as compare to absolute anatomical reduction with compromising soft tissue and vascularity. [4] Biological fixation of fractures with soft tissue preservation and near acceptable reduction is becoming a more acceptable entity. However it is to be evaluated. For a satisfactorily outcome only union is not the only requirement but early and acceptable functional usage of the limb is the goal. Therefore concept of biological fixation was developed over a stable mechanical fixation. [5] This has evolved the development and improvement in the techniques of biological fracture fixation and stabilization systems. [6-7] From conservative cast and braces [8-9] to internal fixation with intramedullary interlocking nailing, [10] ORIF with plate and screw. Treatment of humeral fracture has evolved a lot with their complications. Studies are still going on to prove superiority of one over another [10]. Minimally invasive technique for humerus shaft fracture has shown promising results recently [11-12].

Methodology:

The present study was planned in Department of Orthopaedic, Sri Krishna Medical College and Hospital (SKMCH), Muzaffarpur, Bihar, from jan 2017 to Oct 2017. Total 10 cases with fractures of humerus shaft were treated with Minimum invasive Anterior Bridge plating techniques were evaluated in the present study.

All the patients were informed consents. The aim and the objective of the present study were conveyed to them. Approval of the institutional ethical committee was taken prior to conduct of this study.

Following was the inclusion and exclusion criteria for the present study.

Inclusion Criteria: fracture of humerus between 21 and 75 years and who consented to participate in the study. The operative procedure was performed within 5 days of the injury.

Exclusion Criteria: coexisting medical disorders (such as a malignant tumor and hyperparathyroidism), vascular insufficiency of the upper limb, polytrauma patients with an injury severity score[16] of >16 points, patients with known alcohol or drug dependency, and those participating in other clinical trials.

Operative Technique: local brachial block with ultrasound guided. A Distally, a 2-3 cm incision at the lateral border of the biceps, nearly 5 cm proximal to the flexion crease. Retraction of biceps was done to expose the musculocutaneous nerve, overlying the brachialis muscle. The nerve is then retracted and brachialis muscle was split till bone. The lateral half of brachialis muscle then protects radial nerve. A sub-brachialis, extra-periosteal tunnel was created with long stripper then a 2-3 cm incision between the medial border of deltoid and proximal biceps, 5 cm caudal to the acromion process was made, 4.5-mm dynamic compression plate is passed through the incision on the anterior surface of the humerus from distal incision. Varus/ valgus angulation, length and rotation are restored by traction. Confirmation of the reduction done under image intensifier. Each side of the plate is fixed with two screws in anterior to posterior direction. During the the process of making tunnel atmost care is take to be in anteriorplane of humerus to prevent iatrogenic damage to radial nerve. The amount of force required to be used for manual traction for achieving proper reduction was not easy at first, but becomes easy as technique is practiced. The ‘cortical step sign’ as described by Krettek [13] is used to look for any rotational malalignment. The operative time (skin incision to closure) and duration of radiation exposure (in seconds) was recorded. Postoperatively, shoulder immobilizer was applied.

Results & Discussion:

Tscherne and Krettek first reported minimal invasive osteosynthesis for fractures in 1996. [14] Since then this technique is used in managing various other fractures. Despite the requirement of high surgical expertise and time taken for adaptation of the procedure, the MIPO technique seems to be reproducible and applicable in almost all types of shaft humeral fractures. Lower rates of iatrogenic nerve injury with minimal bone vascularity disruption, and soft tissue dissection are all the advantages over conventional plate technique. Though indirect reduction and plate placement is technically difficult and requires experience, Plates can be safely used anteriorly or anteromedially over the humeral shaft. Bridging the fracture fragment, with fixation only at either ends of the plate and bone. Excellent to good results have been achieved with sub brachialis plating with no major soft tissue problems and with functional results as per other methods. [15] Open technique of plating interferes with the local vascularity, leading to osteonecrosis underneath the plate, which may cause delayed healing to non healing (published rate of nonunion being 5.8%). [16] Union of the humeral shaft fractures in this series presents good results with fixation through indirect reduction aims at maintaining bone alignment through mini incision and replacing absolute stability by relative stability. This bridgeplate technique can be used even for the treatment of humeral shaft nonunion (both atrophic and hypertrophic nonunion). [17]

Minimally invasive technique for fracture treatment has evolved based on the idea that with the preservation of fracture haematoma and the vascularise around the fracture site, new bone is layed down in the form of callus and led to the success of the MIPPO technique for fracture fixation at other sites and lies in the fact that using long plates across zones of extensive fracture fragmentation with only few screws on either side of the fracture. [18-19] It is now known from the literature that fixation of diaphyseal fractures of long bones should preferentially be done using the principle of relative stability, by means of minimally invasive techniques, thereby enabling formation of a bone callus. The humerus bone has a wide range of acceptability criteria in its reduction and is highly amenable to conservative management. However, it requires the continuous use of a cast/splint for 6–8 weeks, which is usually cumbersome for the patient. This option is not very suitable for young active individuals who need to begin their activities at the earliest. So, these patients are better suited for an early operative intervention. [20]

Table 1: Sex & Age Distribution

Parameters	**No. of Cases**
Sex:	
Male	7
Female	3
Age:	
20 – 30 years	1
31 – 40 years	1
41 – 50 years	3
51 – 60 years	3
60 years & above	2
Total	10

Table 2: Distribution of side of injury

Side of injury	Number
Right	8
Left	2
Total	10

Majority of side of injury were found right side (80%).

Table 3: Distribution of extent of displacement of fractures

Extent of displacement of fracture (cms)	**Number**
< 2	0
2-5	8
> 3	2
Total	10

The patient's clinical condition and activity level, fracture type and localization and the surgeon's experience are important determinants in deciding the most suitable alternative. Minimal invasive methods gained popularity with bridging plate osteosynthesis in the last decade. However, few studies have reported on humerus fractures. In 2004, Livani and Belangero concluded that MIPPO is a feasible, safe and efficient method with no major complications in the treatment of humerus shaft fractures. [21] Better results have also been reported with MIPPO compared to the conventional surgical techniques in terms of providing a shorter recovery time by early stabilization with minimal soft tissue damage. [22] Aksu et al. reported early return of function in adjacent joints to the fracture site and reduced fracture healing time after MIPPO in humerus fractures. [23] However, further clinical studies are needed to state the proven benefits of MIPPO in the treatment of humerus shaft fractures.

MIPO for humeral shaft fractures has been reported earlier [24] with fair results. MIPO scores over open reduction and plate fixation of humerus fractures by decreasing the surgical trauma to the soft tissue and maintaining the periosteal circulation. Application of the plate on the bone by an open technique interferes with the local vascularization, leading to osteonecrosis beneath the implant, which can cause delayed healing or non-healing (the reported rate of nonunion being 5.8%). [25] The primary bone healing without callus formation is not very strong and there exists a real risk for refracture after removal of the implant in the open technique. [26-27]

Apivatthakakul et al. [28] also pointed out that when the forearm was pronated, the radial nerve was noted to move medially closer to the distal end of the plate and was at risk of iatrogenic injury. For this reason, the supination position of the forearm should be maintained during the operation. In another study, [29] postoperative ultrasonographic measurement of the distance between the radial nerve and the material implanted using the MIPO technique was calculated and the authors reported that the point of greatest proximity of the radial nerve and the implant in a humeral shaft fracture was between 1.6 and 19.6 mm (mean: 9.3 mm) and in distal-third fractures it was between 1.0 and 8.1 mm (mean: 4.0 mm). The brachialis muscle covers the humerus anteriorly and protects the radial nerve from injury when a plate is inserted submuscularly through two small incisions on the anterior side of the arm away from fracture site, supporting our findings of no radial nerve palsies with the technique used.

The present technique through its less tissue dissection and periosteal stripping makes a promising modality of treatment. In conclusion, this series demonstrates that the anterior minimally invasive bridge-plate technique for treatment of humeral shaft fractures presents newer, effective, cosmetically advanced (minimal operative site scar) and acceptable modality of treatment for such fractures. Though the technique is complex, requiring a relatively long learning time the results are good and reproducible. However a larger multi centric metanalytical study with control groups will help us to arrive at a standardize protocol. To conclude, MIPO is definitely a newer and acceptable modality of treatment.

Union of the humeral shaft fractures in this series presents good results with fixation through indirect reduction aims at maintaining bone alignment through mini incision and replacing absolute stability by relative stability. This bridgeplate technique can be used even for the treatment of humeral shaft nonunion (both atrophic and hypertrophic nonunion). [30] The present technique through its less tissue dissection and periosteal stripping makes a promising modality of treatment.

Conclusion:

The data generated from the present study concludes that though the technique is very promising, it has a steep learning curve involved. The greatest advantage is minimally invasive, minimal soft tissue stripping, smaller incisions, minimal blood loss, shorter operative time and early rehabilitation. In conclusion anterior bridge plating (ABP) is very good technique in treating midshaft humeral fractures with minimal soft tissue dissection, smaller scars, and early return to overhead activities.

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