Novel Adaptation of Suture Bridge Technique for Greater Tuberosity Redisplacement Post ORIF With PHILOS- A Technical Note

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Abstract

Isolated Greater tuberosity (GT) fractures still pose a therapeutic challenge due to the wide variety of treatment options and lack of proper compar ative studies on outcome. Plating still remains a valid option but has several unfavorable effects. One among them is redisplacement of tuberosity postoperatively especially in cases with comminution which may easily be missed in regular plain radiographs. Conventional techniques of fixation may remain insufficient in such scenarios. We hereby propose an adaptation of a described technique, in a 45 year old male presenting with redisplacement of GT post plate fixation. Open double row suture bridge construct was used to fix the displaced fragment maintaining the plate insitu and patient had excellent functional and radiological outcome on follow up.

Keywords: Greater tuberosity fracture; Comminution; Double-row fixation; Suture anchor; Suture Bridge technique; PHILOS; Redisplacement.

Introduction

Isolated greater tuberosity(GT) fractures are often encountered in practise as they comprise around 17 – 21% of all proximal humerus fractures occurring in various age group patients [1, 2]. Various treatment modalities have been described previously based on the fracture pattern, size of the fragment, displacement, bone quality ,associated injuries etc.. Open reduction and internal fixation(ORIF) using anatomical or non anatomical plates is a valid option in indicated cases [3–7]. Most common complications reported are screw penetration, tuberosity malunion, impingement, stiffness and implant failure. Secondary displacement of GT after successful primary ORIF using plate is only rarely reported [3, 7, 8]. No studies have provided any treatment recommendation for this complication. We hereby propose an adaptation of a described surgical technique for the management of this complication without revising the original implant.

Technical Note

45 year old male had a Road traffic accident and sustained shoulder dislocation with fractured and displaced GT (fig. 1). The shoulder was reduced and GT fixed using anatomical plate via deltopectoral approach by the index surgeon. Immediate postoperative radiographs showed a satisfactorily reduced GT (fig. 2). Two months later he presented to us complaining about his inability to elevate the upper limb. Postoperatively he had 6 weeks of passive mobilization, and was started on active assisted rehabilitation for which he responded poorly. On examination he had only grade 2 power in abduction and external rotation. Radiograph and CT scan showed > 20mm postero-superiorly displaced GT with plate insitu (fig. 3, 4). The treatment we proposed was an open reduction and internal fixation with double row suture bridge technique retaining the implant insitu.

Surgical technique

Standard protocol was followed for anesthesia with general anaesthesia and Interscalene block .The patient was in beach chair position with 45 degree inclination and the site was prepped and draped with the arm allowed to move freely or hang besides.

Deltoid splitting approach was preferred over reopening the healed deltopectoral wound. This was considering the better visualization and manipulation of the supraspinatus cuff and the more posteriorly placed infraspinatus cuff (which tends to pull the attached GT fragment posteriorly also). Incision was planned taking into consideration the site of previous deltopectoral incision leaving a healthy skin bridge in between. The incision was placed starting from a point over the acromion 2 cm behind its anterior most corner (fig. 5).

The deltoid was split for a length of about 4-5 cm without releasing its origin from the acromion. The subdeltoid bursal tissue was debrided and the displaced GT fragment was identified (fig. 6). We expected a failure of the previously placed sutures passed via supra and infraspinatus tendons tied over the PHILOS plate suture holes . But all the sutures were found intact, instead the sutures have cut through the cuff tissue longitudinally along its fibres continuos with the lines of the comminution in GT. This has resulted in superior and posterior migration of the GT as a whole leaving the intact plate sutures behind. Another observation was that the lateral distal margin of the GT fragment corresponded to the proximal row of screws in the plate. This was supposedly due to the multiple breaks in the GT fragment during screw application which later coalesced postoperatively during the pull on GT via Cuff. That explained the smaller size of GT fragment before

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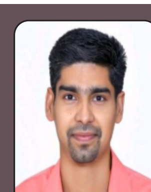
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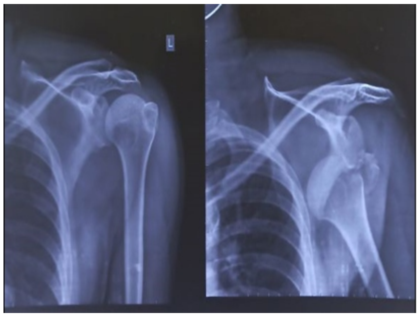

Figure 1: Post And Pre Reduction Image Of Index Dislocation

Figure 2: Immediate Postop Image After Index Surgery

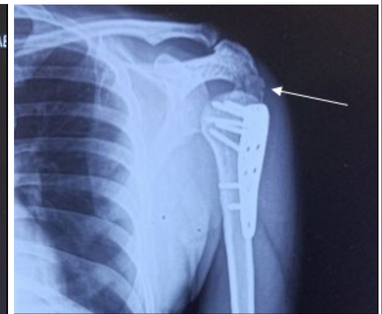

Figure 3: Eight Weeks Postop Image Showing Displaced GT(arrow)

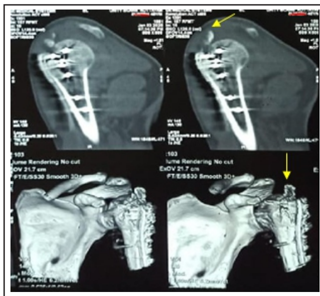

Figure 4: Postoperative CT At 8 Weeks showing displaced GT(arrow)

Figure 5: Late Picture Showing Site Of Both Incisions

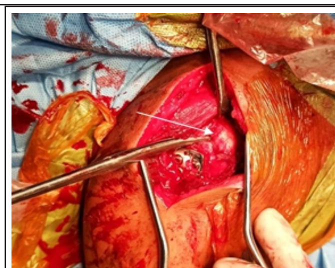

Figure 6: Intraoperative Image Showing Secondary Displaced GT (at the tip of scissors) With Attached Cuff Tissue(arrow)

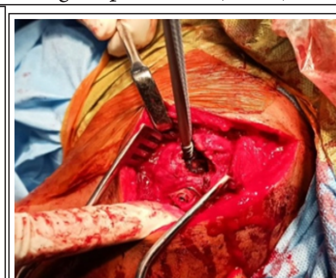

Figure 7: Applying Medial Row Titanium Anchor At Deadman Angle of 45

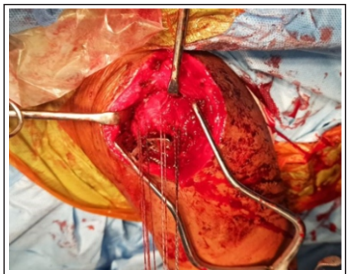

Figure 8: After Passage Of All The 8 Threads From Two Double Loaded Medial Anchors

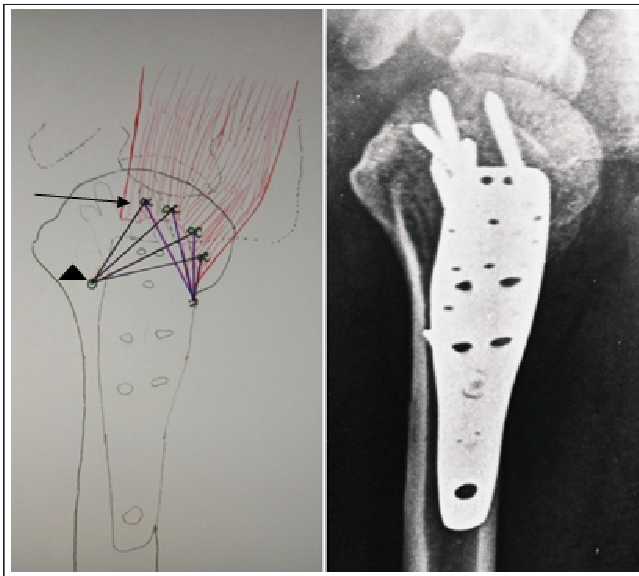

Figure 9: (Left) Schematic Diagram Of The Double Row Suture Bridge Showing The Medial Row Knots(Arrow) And The Lateral Row Knotless Anchors(Arrow Head) Forming A Crisscross Pattern Of Threads Compressing GT Like A Mesh Preventing Redisplacement Of Comminuted Fragments .(Right) Xray Image Of The Projection Used In Schematic Diagram

Figure 10: Immediate Postop image .The double row of anchors can be noted (arrow)

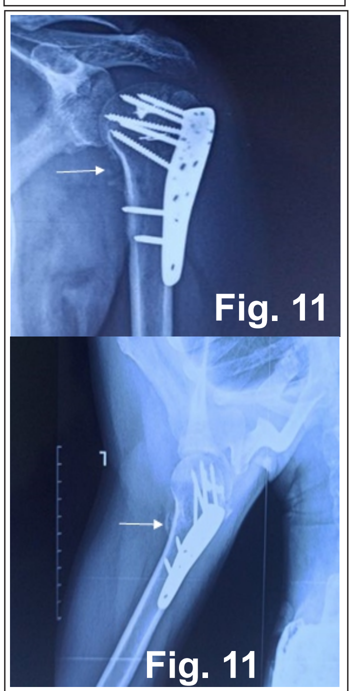

Figure 11: Six Months Postop AP and Lateral Images Showing Well Reduced GT. Heterotopic Ossification Can Be Noticed At Calcar Region (arrow)

Figure 12: Active Abduction Of 160 Degree At 6 Month Followup

reoperation compared to the fragment size before index surgery (plating).

Stay sutures were applied on the cuff in supraspinatus and infraspinatus for manipulation. The fracture bed was freshened. As demonstrated in the figure 7, two medial row anchors (5 mm double loaded titanium)were applied 1.5 cm apart in an area whereby maximum purchase was obtained in the cancellous bed. The eight thread ends were passed serially through supraspinatus and the infraspinatus using retrograde suture passers 1cm medial to the bone tendon interface. Reduction was assessed by pulling on the threads laterally (fig. 8) to confirm whether the GT would remain atleast 0.5 mm below the head once the second row is later applied. Medial row knots were serially tied in mattress fashion.

Of the 8 loose threads from four knots one thread from each knot was grouped together to form two groups of four threads. The threads were buried using self tapping knotless anchors (as done in a case of lateral row of double row rotator cuff repair) just adjacent to the anterior margin and posterior margin of the plate leaving a safe strip of bone(fig. 9). Bone awls were used for entry for the lateral row anchors as the cortical bone was hard in this region. In doing so a crisscross mesh of threads were available pressing down the GT comminuted fragments as a single unit further preventing the redisplacement, in contrast to the previously applied suture cuff bites tied to the plate which failed cutting through the cuff leading to GT redisplacemnet. The joint is moved through entire range of motion to assess the reduction and rule out impingement (due to malreduction or downsloping acromion) on abduction or external rotation. The cut through longitudinal tears in the rotator cuff were repaired with absorbable sutures. The deltoid split is reapproximated and the surgical site is closed in layers.

Follow up

Immediate postop image showed well reduced GT (fig. 10). The limb was maintained in sling with pendulum exercises only. Passive elevation to 45 degree and external rotation to 10 degree was started after suture removal and passive ROM gradually increased in following 6 weeks. Active strengthening exercises was started after 6 weeks. 6 months postop xray showed well healed GT in AP and axial view (fig. 11). He attained passive and active abduction of 160 degree with grade 5 power at 6 months followup (fig. 12). His external rotation was 10 degree short compared to other side. The terminal restriction of extreme ROM was attributed to the arthrofibrosis post two open procedures and associated heterotopic ossification at inferior capsular region (fig. 11). His constant score at 6 month was calculated to be 90 and graded as excellent. He accepts the ROM and is fully back into his occupation.

Discussion

GT fractures have been conveniently classified with good interobserver reliability into three major groups namely- vertical split (associated with anterior shoulder dislocation) horizontal fracture (avulsion type) and the depressed type (against glenoid or acromion) with varying treatment options for each type [1, 4, 9].

Accordingly various treatment algorithms have been proposed for greater tuberosity fractures which includes percutaneous screw; open reduction and internal fixation with anatomical or non anatomical buttress plates or cannulated screw fixation with or without washer; tension band techniques like transosseous suture or open/arthroscopic suture bridge constructs [10–14]. All fractures with displacement more than 5mm have been recommended surgical fixation by many authors [5, 15]. Most of the authors who have treated the GT fracture using plates have published favorable results [10, 11, 16]. Major complication reported was malunion and its related secondary problems like impingement, loss of External rotation, stiffness and weakness [11,15]. But only very few studies have reported secondary displacement of GT after a reasonably well performed plate fixation [3, 7, 8]. The reason for failure was not discussed adequately. Park et al reported risk of secondary displacement of GT in comminuted cases treated with regular anatomical plates [5].

For Biomechanical stability screws should be oriented perpendicular to the fracture line. But in comminutesd GT cases, there can be multiplanar orientation of fractures. Posteriorly directed pulling forces of the infraspinatus and the teres minor muscles on the GT fracture fragment is a major displacing force which needs an anterior traction force to counter. The screw orientation of the conventional locking plate cannot resist this traction force, which may lead to secondary displacement [5]. Passage of screw can create further comminution [17]. Regular radiographs fail in interpreting the fracture configuration and degree of comminution. 3D CT scans may provide adequate information in preoperative planning. The fragment size, degree of displacement, degree of comminution, and presence of osteoporosis influence the choice of adequate operative technique [17]. We consider plating as an inferior option in comminuted GT fractures.

Bhatia et al reported an open technique for reduction and internal fixation of comminuted isolated greater tuberosity fractures [9] and later many other surgeons demonstrated the same arthroscopically [5,14,17–19]. It was essentially a suture bridge technique with double row of suture anchors. The superior displacement of GT may lead to limitation in abduction due to impingement and shoulder dysfunction and weakness due to pain and inflammation. The medial row anchors and the mattress knots when applied over the cuff effectively brings down the GT down to a position inferior to the articular margin which is important in the functional outcome [15]. It is important to spread the double loaded anchors adequately according to the size of the GT fragment and the orientation of the rotator cuff fibre. An anchor is to be applied for every 1.5 cm of fracture surface. For adequately countering the cuff pull superiorly and more importantly posteriorly, strategic spots have to be chosen on the cuff (keeping in mind the comminuted fracture configuration) for taking the bites in order to pass the sutures from the anchors in a mattress fashion. On tying the medial knots we can appreciate that the medial edge of the GT which corresponds with the medial end of the cuff footprint is reduced anatomically and further the pull of the cuff on the GT fragment is negated to a large extent. The strain over the medial footprint can be nullified to a great extent by using a second row of anchors as described in routine double row cuff repair constructs. By bringing the threads of the medial row knots laterally in a crisscross manner ample coverage over the comminuted GT fragments is obtained. This method also provides greater contact area and contact pressure for the fragment over the raw area thereby enhancing the healing process [20].

There are numerous studies available on management of greater tuberosity malunion or non union post primary hemiarthroplasty done for trauma. But we could not find any series or reports on secondary displacement of GT in isolated GT fracture cases treated with plating . Handschin et al in their study of functional outcome of plating for proximal humerus fracture reported revision with plate for secondary displacement of GT post primary plating [3] . Solberg reported treating non union of GT with secondary bonegrafting [21]. Our method is far more superior whereby the original implant is retained and the lateral row is applied at a safe distance from the in situ plate. Associated partial rotator cuff tears are reported in GT fracture which can effectively be treated by medial row anchors at anatomical footprint .The displacement was more than 20 mm and hence arthroscopic procedure was not considered for fixation [17].

Implant removal was deferred during second surgery since it was only two month post the index surgery and adequate healing of the non displaced insitu retained portion of primarily fractured GT was not expected. Our experience also makes us believe that atleast multiple xray views or preferably CT scan is recommended in all GT fractures. The degree of comminution is of grave significance in selecting the mode of fixation of GT. We consider Plating as an inferior option in cases of comminuted GT fractures. Further research with higher level of evidence is required to substantiate our hypothesis.

Conclusion

The anatomical plating or regular tension band fixations are inferior compared to double row suture bridge fixation for isolated greater tuberosity fractures in the presence of comminution. Even in non comminuted cases, plating is too invasive compared to an equally good alternative of suture bridge technique with lesser complication rate. CT scan is recommended in all cases irrespective of presence of comminution in the plain radiograph. Secondary displacement of GT can effectively be treated by suture bridge technique retaining the insitu implant.

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