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Technique of accurate humeral length restoration for hemiarthroplasty of the shoulder in proximal hummers fractures

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Abstract
Proper humeral height is key to success in shoulder hemiarthroplasty in comminuted fractures of proximal humerus. Restoring it in a precise way results in excellent functional outcome. Pectoralis major tendon serve as a reliable landmark for this purpose. Preoperative templating by Gothic Arch technique was almost comparable to intraoperative measurement using pectoralis major tendon as reference. Purpose of this study was to evaluate the accuracy of the surgical technique using pectoralis major tendon as reference for restoration of humeral length.

Keywords: humeral length, hemiarthroplasty and proximal hummers fractures

Introduction
Restoration of proper humeral length is one of the key component for success in functional outcome of hemiarthroplasty in proximal humerus fractures. Restoration of accurate humeral length is challenging due to disruption of medial metaphysis calcar in comminuted proximal humeral fractures. Placing the prosthesis too low or high can cause improper tensioning of the deltoid and supraspinatus. Lengthening may result in tuberosity detachment, rotator cuff failure and impingement, whereas shortening reduces length and tension of the deltoid muscle, thus impairing its function [1]. Subjective judgment in selecting prosthetic height may lead to non-anatomic reconstruction and poor clinical results. Several fracture jigs (Aequalis [2], Thornier SA, Montbonnot, France and Global Advantage Shoulder, De Puy Orthopedics, Warsaw, IN) are available but may be difficult to use. The purpose of this article is to describe a reliable surgical technique using the pectoralis major tendon insertion as a reference for the determination of the humeral component height during hemiarthroplasty reconstruction for proximal humerus fractures.

Preoperative planning
Patients who are candidate for shoulder hemiarthroplasty, full length radiograph (figure 1A & 1B) of both humeri must be taken in order to determine the appropriate humeral head height [3]. These radiographs must include the entire length of the humerus and must be controlled for magnification. Pre-operative calibrated radiographs of the both the fractured and the contralateral humerus are essential to determine humeral length, canal diameter, and head size. Two radiographic markers at equal distance must be placed on lateral aspect of both humeri in order to quantify the effect of magnification of the radiograph. It is essential that the marker not be placed anterior or posterior to the humerus, as this position change will potentially modify the magnification effect on the humeral length measurement. The humeral length which is to be restored is measured by Gothic Arch technique [4] which is explained as follows:

1. Actual length (L1) of normal humerus is calculated as:
$L1=L' \times l' \div l''$
L'= Humeral length measured on radiograph (distance from the superior most part of humeral head to transepicondylar axis along the prosthetic axis)
l'= known distance between two radiographic markers.

l'= known distance between two radiographic markers.
L''=distance measured on radiograph between two radiographic markers.

2. Length of fractured humerus (L2) is calculated as:
L2=L'×l'÷l''
L'=Humeral length measured on radiograph (distance from the medial fracture line to the transepicondylar axis along the prosthetic axis)
l'=known distance between two radiographic markers.
l''=distance measured on radiograph between two radiographic markers.
The difference between L1 and L2 gives the value by which humeral head height is to be restored.
This measurement forms a basis for the surgical reconstruction technique and is compared with the method using the pectoralis tendon as reference.

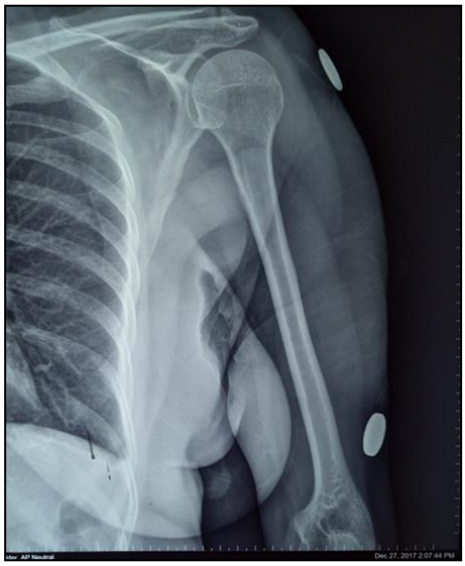

Fig 1A: Showing full length radiograph of normal humerus

Fig 1B: Showing full length radiograph of fractured humerus

Surgical Technique
The patients are positioned on the operating table in semi-sitting position (beach-chair). The entire upper extremity is prepared and arm draped free. The deltopectoral approach is taken. The skin incision is started at the tip of the coracoid process and is extended distally and laterally approximately 10-15cm. The interval between pectoralis major and deltoid was identified by locating the cephalic vein and was retracted laterally with deltoid muscle. The conjoined tendon is identified and traced to its insertion on the coracoid process and was retracted medially to expose the proximal humeral fracture. The biceps tendon is released from the bicipital groove and followed proximally to define the rotator interval. It may then be tenotomized at its origin on the superior glenoid labrum. The joint is opened, and stay-sutures are placed separately through the greater and lesser tuberosities. The humeral head fragment is identified and was removed with locking forceps. Head is kept on the sterile field for later use as a bone graft material and for size match with prosthetic head. The humeral shaft is exposed by extending and adducting the arm. The humeral shaft is reamed to determine canal size. A trial implant is assembled using a stem diameter corresponding to the last reamer used, a 130° neck, and a head corresponding to the fractured head diameter. The trial component is inserted into the canal in the proper orientation, and impacted such that the top of the humeral head is 5.6 cm above the upper border of the pectoralis major tendon [5] insertion on the humerus. This should be confirmed with the height measured radiographically and marked on pre-operative templating. Twenty degrees of humeral head retroversion is determined using the bicondylar axis of the humerus with the arm in neutral rotation and the elbow flexed 90 degrees. The trial humeral component is then reduced into the glenoid. With the arm in neutral rotation the prosthesis should be assessed for proper centering in the glenoid, as well as for stability. Two holes are drilled in the humeral shaft straddling then bicipital groove 1 cm distal to the fracture site at the fracture line. Two number non absorbable sutures were placed so that they exit through the cortex of the shaft. These were used later for figure of eight fixation. A cement restrictor is placed in the the shaft 1.5 cm distal to the stem. The stem is then cemented in place over a version guide. The trial head is placed. Proper head size and height allowing approximately 50% anterior- posterior translation and 25% inferior translation with regard to glenoid is chosen. Proper height is achieved by measuring the distance from superior margin of pectoralis major insertion to superior aspect of prosthetic head which is 56 mm [5]. The trial is removed and prosthetic head was placed on the stem. Graft from the humeral head is prepared and placed at the tuberosity-stem interface. The Tuberosities are reduced and fixed by the previously placed sutures in a circlage fashion and the shaft sutures in a figure of eight fixation. Fixation of the greater tuberosity in relation to prosthetic head is aimed at in the range of 5-10 mm below the superior aspect of prosthetic head.

Discussion
Biomechanical considerations
Poor functional results are associated with non-anatomical reconstruction, either in length or retroversion of the proximal humerus [6, 7]. The tendency to shorten the humerus may lead to shortening of the muscular fibers of the deltoid. This permanent contracture of the deltoid and associated muscles compromises active anterior elevation of the shoulder by decreasing their lever arm. Humeral lengthening has even worse consequences, such as pain and limited range of motion, due to the superior humeral migration and abnormal joint compression forces, which may lead to anterosuperior impingement [1]. Components placed in excessive retroversion, especially greater than 30-40°, can lead to a poor

reconstruction of the tuberosities with over-tensioning of the posterosuperior cuff [1, 7].This can cause pullout of the sutures and posterior migration of the greater tuberosity with fracture nonunion or malunion. The bicipital groove, usually cited as a reliable reference during reconstruction, is an imprecise landmark. The course of the bicipital groove is 'S' shaped and is axially oriented in its lower part. Positioning the proximal humeral prosthesis in relation to the lower bicipital groove can increase the retroversion by 20° [8].

Anatomical Study

Gerber *et al.* [9] performed a cadaveric study to determine a reliable bony or tendinous landmark which could be used as a reference point during proximal humeral reconstruction. The pectoralis major *tendon* was selected, as it is well-defined, easily identified, and consistent in location. Twenty-six human cadaveric upper extremities were dissected, and the insertion of the pectoralis major tendon was exposed. A three-dimensional (3D) digitizer was used to map the surface of the proximal humerus and the humeral insertion of the pectoralis major tendon. A 3D-computer model was then created to calculate the distance between the upper part of the pectoralis tendon and the highest point of the humeral head. Despite examining a wide range of specimens with respect to age, sex and diameter of the articular surface, this distance remained fairly constant (mean 53.9±5.9 mm, range 42.4-59.7 mm). Therefore, the mean distance between the upper border of the pectoralis major tendon and the highest point on the humeral head may represent a simple parameter to estimate and restore humeral length.

Clinical Results

This operative technique was been applied to 20 cases. The patients included 5 females and 15 males, with a mean age of 55.4 years. All patients were right hand dominant, and in five patients was the non-dominant arm fractured. Preoperative and post-operative humeral length measurements were performed using the technique described above. Post-operative radiographs of humerus (Fig 2) were taken and a calibrated radiograph of the affected humerus. The post-operative humeral length measures are reported in Table 1. The pectoralis major tendon improved the

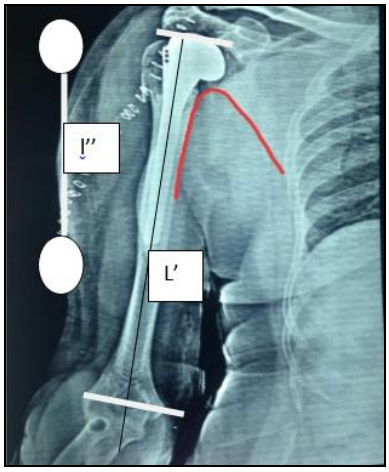

Fig 2: Showing full length post operative radiograph of humeros

Positioning of the prosthesis with regard to the humeral length. Using this landmark, prosthetic positioning was relatively precise, with humeral length restored to within 4.26 mm of the unaffected side.

Table 1: Postoperative humeral heights

Fractured humerus length(in mm)	Contralateral humerus length (in mm)	Length difference (in mm)
328.26	325.20	3.06
320.80	322	-1.8
334.20	332.20	2
310.28	307.16	3.12
315.26	311.16	4.10
318.12	322.90	-4.78
330.22	324.62	5.60
318.14	314.28	3.86
316.20	321.52	-5.32
306.14	310.30	-4.16
324.24	320.20	4.04
328.22	324.10	4.12
305.68	310.60	-4.92
329.22	324.10	5.12
298.62	303.42	-4.80
308.12	304.62	3.50
316.26	310.48	5.78
326.24	330.18	-3.94
302.16	309.10	-6.94
304.20	300.42	3.78
Average values		4.26

Conclusion

Anatomic placement of a proximal humeral prosthesis used for reconstruction of a complex proximal humerus fracture is challenging. Priority should be given to the precise positioning of the prosthesis with regards to height and version. On the basis of this anatomic study, we propose that the pectoralis major tendon can be used as a reliable landmark to determine the prosthetic component height, regardless of component selected.

References

1. Boileau P, Krishnan SG, Tinsi L, Walch G, Coste JS, Molé D. Tuberosity malposition and migration: Reasons for poor outcomes after hemiarthroplasty for displaced fractures of the proximal humerus. J Shoulder Elbow Surg. 2002; 11(5):401-412.

2. Boileau P, Walch G. Preoperative planning and the use of the fracture Jig. In: Walch G, Boileau P, editors. Shoulder arthroplasty. Heidelberg: Springer-Verlag, 1999, 315-321.
3. Boileau P, Walch G. Shoulder arthroplasty for proximal humeral fractures: Problems and solutions. In: Walch G, Boileau P, editors. Shoulder arthroplasty. ed. Heidelberg: Springer-Verlag. 1999; 1:298-314.
4. Krishnan SG, Pennington SD, Burkhead WZ, Boileau P. Shoulder arthroplasty for fracture: Restoration of the" gothic arch". Tech Shoulder Elbow Surg. 2005; 6:57-66.
5. Murachovsky J, Ikemoto RY, Nascimento LG, Milani C, Warner JJ. Pectoralis major tendon reference (PMT): A new method for accurate restoration of humeral length with hemiarthroplasty for fracture. J Shoulder Elbow Surg. 2006; 15(6):675-678.
6. Bigliani LU, Flatow EL, McCluskey, Fischer RA. Failed prosthetic replacement for displaced proximal humeral fractures. Orthop Trans. 1991; 15:747-748.
7. Compito CA, Self EB, Bigliani LU. Arthroplasty and acute shoulder trauma, reasons for success and failure. Clin Orthop. 1994; 307:27-36.
8. Itamura J, Dietrick T, Roidis N, Shean C, Chen F, Tibone J. Analysis of the bicipital groove as a landmark for humeral head replacement. J Shoulder Elbow Surg. 2002; 11:322-326.
9. Gerber A, Apreleva M, Harrold FR, Warner JJP. The value of the pectoralis major tendon as an anatomic landmark to determine humeral length and retroversion. In: ICSS. 2001; 8:23-26.