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Case Report

Intraoperative CT navigation for glenoid component fixation in reverse shoulder arthroplasty

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Abstract

CT navigation has been shown to improve component positioning in total shoulder arthroplasty. The technique can be useful in achieving strong initial fixation of the metal backed glenoid in reverse shoulder arthroplasty. We report a 61 years male patient who underwent reverse shoulder arthroplasty for rotator cuff arthropathy. CT navigation was used intraoperatively to identify best possible glenoid bone and to maximize the depth of the fixation screws that anchor the metaglene portion of the metal backed glenoid component. Satisfactory positioning of screws and component was achieved without any perforation or iatrogenic fracture in the scapula. CT navigation can help in maximizing the purchase of the fixation screws that dictate the initial stability of the glenoid component in reverse shoulder arthroplasty. The technique can be extended to improve glenoid component position [version and tilt] with the availability of appropriate software.

Key words: Computer-assisted surgery, CT navigation, reverse shoulder arthroplasty, rotator cuff arthropathy

Introduction

Reverse shoulder arthroplasty [RSA] is chiefly indicated in patients with rotator cuff arthropathy.[1] Accurate glenoid component placement is paramount to a successful shoulder arthroplasty procedure.[2] The glenoid component in reverse shoulder arthroplasty consists of a base plate, which requires to be rigidly fixed using locked and nonlocked screws. The central glenoid peg in most designs is hydroxyapatite (HA) coated which allows for bone ingrowth ensuring long term stability. Computer assisted surgery, both CT based and image free navigation, has been shown to improve component placement in total shoulder arthroplasty[3] and we believe that the same will apply in RSA also. Apart from component positioning, CT navigation can also help in improving screw length and purchase, which are important for immediate and long term stability in a RSA. We present a case of CT guided RSA in a rheumatoid patient with rotator cuff arthropathy and discuss the advantages of the procedure and review the literature.

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Case Report

61 years male from Nigeria with longstanding rheumatoid arthritis presented with a painful left shoulder. The clinical evaluation showed a weak rotator cuff. The cuff deficiency was also confirmed preoperatively with a magnetic resonance scan. True anteroposterior and axillary radiographs along with a 3D computerised scan were taken as part of the preoperative evaluation. AP X-rays were assessed for squaring of the axillary border of the scapula.[4] Glenoid version, available glenoid bone and defects were assessed using the CT scan.[5,6] Version was measured as glenoid inclination at the level of a transverse plane through the center of glenoid perpendicular to the scapular body. The transverse plane was generated perpendicular to the midpoint of a line drawn on the glenoid fossa centered in AP direction which was calculated using 3D reconstruction as described by Hoenecke Jr *et al*.[6] The glenoid preoperatively was retroverted by 7° [Figure 1].

The patient was operated in beach chair position by standard deltopectoral approach. Preparation of the humerus for component placement was done as per the guidelines of the component manufacturer [Delta CTA, reverse shoulder system, Depuy, India]. A positioning pin was placed in the coracoid process and the infrared markers were attached for intraoperative navigation. Registration was done using

the intra operative CT [Brainlab] and the data were fed into the navigation suite to facilitate glenoid component fixation. The glenoid cavity was reamed conservatively in a plane perpendicular to the face of the glenoid till subchondral punctate bleeding was evident. The metaglene was positioned such that it sits flush with the inferior glenoid rim without overhang. Minor adjustments can then be made in the anteroposterior plane to maximize host bone contact and to identify the best possible bone stock for peg and screw fixation. After confirming position, the guide wire for the central peg was inserted using precalibrated instruments. The CT images in three planes were used to assess the position of the central peg before reaming so that there is no perforation. The superior and inferior locking screws were inserted in the best possible trajectory to improve purchase and screw length. The anterior and posterior nonlocking screws were inserted similarly using CT images to achieve the best possible screw position [Figure 2]. Remaining part of the procedure was done according to the recommendations of the manufacturer.

Component positioning was confirmed to be satisfactory in the post operative X-rays [Figure 3] and postoperative CT at 2 weeks revealed a glenoid anteversion of 2° and inferior tilt of 5°. None of the fixation screws or the central peg had perforated the glenoid bone.

Discussion

The glenoid component in reverse shoulder arthroplasty is secured using a combination of locking, nonlocking screws, and a central peg with or without HA coating. Secure fixation of the all metal glenoid component to the glenoid is one of the unique features of the reverse total shoulder arthroplasty. This secure fixation depends on proper preparation of the bone, positioning of the component, and screw placement. CT navigation provides a real time 3D feedback on the quality of glenoid bone available which can be utilized to provide optimal initial fixation of the glenoid component.

Previous reports on CT and non CT based navigation systems in shoulder arthroplasty have shown accurate assessment of the glenoid deformity and component placement can be achieved intraoperatively.[7-9] In the only randomized trial published so far on the topic, Kircher *et al.*,[10] reported that CT navigation significantly improves glenoid component positioning in the transverse plane in conventional total shoulder arthroplasty. No prospective clinical study has so far been reported on the use of CT navigation in RSA but the technique on cadavers has yielded satisfactory results. Verborgt and colleagues[11] in a cadaveric study comparing CT navigation and conventional

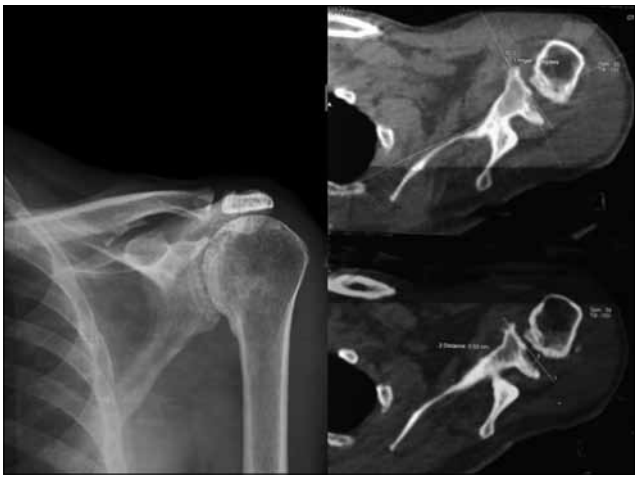

Figure 1: Pre operative Xray and CT images showing proximal migration of the humeral head, sclerosis and secondary erosions of the acromion suggestive of long standing rotator cuff arthropathy. The preoperative glenoid retroversion was 7° and depth of the posterosuperior glenoid defect was less than 1 cm

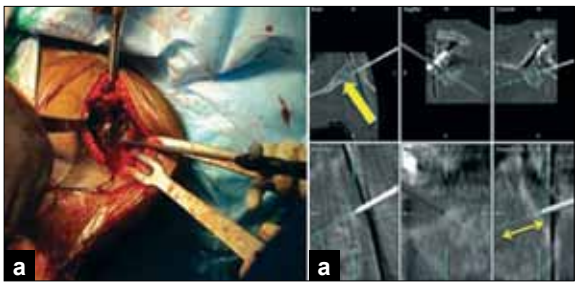

Figure 2: (a) Clinical peroperative photograph showing insertion of glenoid component (b) 3D CT images greatly help in improving purchase of the nonlocked screws by identifying best trajectory for the screw [thick yellow arrow]. Lower case screen caps just show a magnified version of the above images. The distance between each consecutive stop measures 10 mm [double headed arrow] which gives the appropriate screw length without perforation

Figure 3: operative X-ray showing Arthroplasty implants *in situ*

technique concluded that CT navigation significantly improves glenoid component positioning in reverse shoulder arthroplasty. Of the 14 cases in each group, there

was perforation of the superior screw in four patients and the inferior screw in one patient. The glenoid component in our patient was positioned conventionally because of lack of software. We aimed for 0° version and 10° of inferior tilt. The CT navigation was used only for positioning of the fixation screws.

Given the importance of the fixation screws in RSA, (i) use of the longest possible screws without perforation and (ii) use of the best available bone can help in improving outcomes following RSA. Both of these can be achieved consistently with the use of CT navigation.[6] Scapular fractures have been reported following RSA due to improper screw placements.[12] Most of the type III fractures [fractures of the posterior acromion and scapular spine fractures] are associated with the superior screw and authors previously have advised against the use of the superior screw.[12] CT navigation, by avoiding improper screw directions and perforations might decrease the risks of subsequent fractures and soft tissue impingements during shoulder movements.

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