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Contribution of automated scannographic measurement in the glenoid component planification in reverse shoulder prosthesis at CHU de Dijon: According to 34 cases

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Abstract

Introduction: The precision in the placement of a glenoid support in reverse shoulder prosthesis is the most important factor defining the long-term evolution of the prosthesis. We put in place an automatic measure of the version and the glenoidien inclination on various incidences of a 3 dimension scannographic view. This study had as objective to evaluate the planification realized in 34 patients in whom the protocol was applied in the CHU de Dijon.

Methodology: Our study was based on 34 patients who benefitted from a reverse shoulder prosthesis indicated for shoulder arthrosis at university hospital of Dijon. We compared the orientation of the glenoid implant chosen in the course of the planification with the aid of the software Personalfit® with the initial position of the glenoid cavity measured on preoperative scans.

Results: The average preoperative inclination angle measured on CT scan images was 6,5°, with a maximum of 27° and a minimum of 13°. The version was 11,3°, with a maximum retroversion of 31°. On the planification, the average inclination was at 8,6°, with a minimum inclination of 2° and a maximum inclination of 21,5°.

Discussion: The values that we obtained from our method are similar to those described by other studies in literature.

Conclusion: Thanks to preoperative planification with the use of CT scan, the added correction to the orientation of the glenoid support can be perfectly defined.

Keywords: Shoulder prosthesis, scannographic, arthrosis

Introduction

The precision in Glenoid component positioning in reverse shoulder prosthesis is the most important factor in the long term outcome of the prosthesis [1-3]. The orientation of the glenoid component influences significantly the biomechanics of reverse shoulder prostheses [4]. we devised an automatic measure of the version and the glenoid tilt on 3D scannographic views. [5-7]. This method permits the preoperative measurement of the orientation in patients. These measurements are used for the planification of the orientation of the glenoid component with respect to the corrections in the orientation to be added or used. The fabrication of a patient specific or a personalized ancillary from the planification permits the surgeon to orient the glenoid component in an optimal manner. We compared the orientation of the glenoid which was chosen during the planification with preoperative 3D scan measures of the initial position of the glenoid. The objective of this study was to evaluate the planification of realized in 34 patients to whom this protocol was implemented.

Materials and Methods

This is an observational study conducted at laboratoire d'anatomie UFR santé de Dijon et l'unité Inserm 1093 : Motricité-plasticité (Université de Bourgogne Franche-Comté, Dijon, France. The study population constituted of 4 patients followed at university hospital of Dijon for shoulder arthropathy for which an indication for a reverse shoulder arthroplasty was made.

We used the tilt and the version of 34 glenoid cavities measured from preoperative CT scans and compared with the planned position of the glenoid component, with the use of the website Personal Fit®^[5], which permits the placement of a Duocentric reverse prosthesis with the aid of a premeasured ancillary (PSI : patient specific instrument). The preoperative evaluation was done following the scheme below:

a) Determination of the inclination and version of the glenoid.

The determination of angle of inclination and the version of the glenoid was done using 3D scan images of the scapular.

The orientation of the glenoid was appreciated with respect to body of scapula visualized in one plan. The measures were obtained on the CT scans of 34 patients presenting with shoulder arthrosis

The center of the glenoid CG was obtained by determining anterior glenoid point GA and the posterior glenoid point GP (on the incidence where the anterior posterior diameter determined by an algorithm is biggest [5]), then by drawing a straight perpendicular from GA – GP passing through this point. A scapular plane and a transversal plane passing through the center of the glenoid are then defined (fig.1 et fig.2):

The scapular plane (PS) is obtained by passing through the center of the glenoid CG and the points TS and AI, it's defined by the perpendiculars D1 and D2.

The transversal plane (PT) is the plane perpendicular to the scapular plane (PS) passing through the center of the glenoid CG, and defined by the perpendicular D3.

These perpendiculars D1, D2 and D3 permit us the definition of three orthogonal axes (fig.3 et fig.4): x, y, and z. The angle of inclination of the glenoid is calculated in the scapular plane and the angle of version of the glenoid calculated in the transverse plane (fig 5) (PT).

Using this method, we used the inclination and version of 34 glenoids on preoperative CT scans and compared with the planned position of the glenoid component using the software Personal Fit®^[5], permitting the realization of a Duocentric reverse prosthesis with the aid of pre measured ancillary (fig.6) (PSI : Personal Specific Instruments).

b) The measures: The inclination, ante version, and the tilt

The inclination is said to be superior if the surface of the glenoid is tilted upwards, and said to be inferior if the glenoid is tilted downward with respect to the transverse plane (PT) which represents an inclination of 0.

The ante version is the version of the glenoid towards the front with respect to scapular plane (PS). On the contrary, the glenoid is in retroversion when its surface faces behind the scapular plane.

The tilt: when glenoid component of implant is more oriented in the superior half of the glenoid than the inferior half, we talk of « superior tilt », and when it is more oriented in the inferior half than the superior half, we talk of « inferior tilt ».

Results

Results of the 34 CT scans

a) The orientation of bony glenoid on preoperative scans

Inclination: average inclination 6,5° (it's a superior inclination), minimum inclination: 13° (it's the inferior inclination), maximum inclination: 27° (it's the inferior inclination).

Mean version: retroversion of 11,3°, maximum ante version of 16,5°, maximum retroversion of 31°.

b) Orientation of the glenoid component of implant on planification:

Mean inclination: mean inclination of 8,6°, minimum inclination of 2°, maximum inclination of 21,5°.

Mean version: mean retroversion of 2,9°, maximum ante version of 8°, maximum retroversion of 17,5°.

c) Examples of planification of the orientation glenoid component of the implant with respect to the orientation of bony glenoid.

Example n°1

Measurement of the inferior inclination of the bony glenoid of 13° and measurement of retroversion on scan of 31°,

From these measurements, the position of glenoid component proposed by the surgeon during the planification is an inclination augmented by 8° with respect to the inclination measurement of 13° (the glenoid component has therefore an upward inclination of 21° (8° + 13°) with respect to the inclination of the bony glenoid) and a retroversion of 16° with respect to the version measured (the retroversion of glenoid component was reduced to 16° with respect to the retroversion measured (31° - 15°) on the preoperative CT scan of bony glenoid.). (Fig.7 et Fig.8)

Example n°2

Measurement of the superior inclination of the bony glenoid of 5,5° and measurement of the retroversion of 8,5°.

From the measurements, the position of the glenoid component proposed during planification is an inclination increased by 4° (the glenoid component then has a downward inclination of 1,5° with respect to the inclination of the bony glenoid) and a version of 0° (the glenoid component was in 8,5° ante version with respect to the version of the bony glenoid measured on preoperative CT scan).

Example n°3

Preoperative measurement of the ante version of the bony glenoid of 16,5° and measure of superior inclination of 1,5°

From these measurements, the position of the glenoid component planned by the surgeon was an ante version of 8° (the ante version was reduced by 8,5° with respect to the version bony glenoid measured on scan) and an inclination of 0° (the glenoid component has therefore an inclination reduced by 1,5° with respect to the inclination of bony glenoid measured on scan) (fig.9)

d) Differences between the preoperative glenoid orientation and the planned orientation of the glenoid component

The difference between the planned inclination of the glenoid component of the implant and the inclination of the glenoid measured on preoperative scan: we noted an average increase in the inclination of 2,1°.

The difference the planned version of glenoid component and the version of the glenoid measured on the preoperative CT scan: we noted average an average decrease in the retroversion of 8,4°

The mean correction obtained was an increase in the upward inclination of 2,1° and a diminution in the retroversion of 8,4° of the glenoid component of the implant.

In 31(91%) of the 34 cases, the retroversion of the glenoid

component was reduced with respect to the version of the glenoid measured on preoperative scan. In one case the version of the glenoid was unchanged.

e) Number of persons by category who benefited from a correction of the inclination

Inferior glenoid inclination of 13° to 5° : 1 patient (inferior inclination of the glenoid of 13° . Correction: superior inclination of the glenoid component of 21° with respect to inclination of the glenoid).

Inferior glenoid inclination of 5° to 0° : 5 patients (average inferior inclination of the glenoid = 1.4° . Correction: average superior inclination of the glenoid component 8.7° with respect to the average inclination of the glenoid).

Superior inclination of the glenoid of 0.1° to 5° : 8 patients (mean superior inclination of the glenoid = 3.1° . Correction: average superior inclination of the glenoid component of 3.1° with respect to the mean inclination of the glenoid).

Superior inclination of the glenoid of 5.1° to 10° : 11 patients (average superior inclination of the glenoid = 7.5° . Correction: average superior inclination of the glenoid component of 2.5° with respect to average inclination of the glenoid).

Superior inclination of the glenoid of 10.1° to 15° : 7 patients (average superior inclination of the glenoid = 12.8° . Correction: average inferior inclination of the glenoid component of 3.8° with respect to the average Inclination of the glenoid).

Superior inclination of the glenoid of 15.1° to 27° : 2 patients (average superior inclination of the glenoid = 21.5° . Correction: mean inferior inclination of the glenoid component of 9.3° with respect to the mean Inclination of the glenoid.).

f) Number of patients by category who benefited from a correction of version

Ante version of the glenoid of 16.5° to 5° : 2 patients (mean ante version of the = 11.5° . Correction: mean retroversion of the glenoid component of 7.5° with respect to the mean version of the glenoid).

Anteversion of the glenoid of 5.1° to 0° : 1 patient (anteversion of the glenoid of 1° . No correction).

Retroversion of the glenoid of 0.1° to 5° : 2 patients (average retroversion of the glenoid = 3.8° . Correction : average anteversion of glenoid component of 1.5° with respect to the average version of the glenoid).

Retroversion of the glenoid of 5.1° to 10° : 10 patients (mean retroversion of the glenoid = 6.9° . Correction : average anteversion of the glenoid component of 4.6° with respect to mean version of the glenoid).

Retroversion of glenoid of 10.1° to 15° : 8 patients (mean retroversion of the glenoid = 13° . Correction: Mean anteversion of the glenoid component of 11.6° with respect to the average version of the glenoid).

Retroversion of glenoid of 5.1° to 20° : 7 patients (mean retroversion of the glenoid = 18° . Correction: Mean anteversion of the glenoid component of 13.6° with respect to the average version of the glenoid).

Retroversion of glenoid of 20.1° to 31° : 4 patients (mean retroversion of the glenoid = 25.5° . Correction : Mean anteversion of the glenoid component of 15.8° with respect to the average version of the glenoid).

Discussion

The glenoid cavities studied on preoperative CT scan of patients who presented with omarthrosis Showed that wearing

out of the glenoid was predominant from back (posterior) surface of the Glenoid, resulting in the retroversion of the glenoid. But this phenomenon is not constant as 3 patients presented with an anteversion glenoid. The measure of preoperative retroversion of the glenoid is an essential given that in our study, this measurement resulted in the correction of 5° to 16° in 29 of 34 patients. The values we obtained through this measurably comparative to other series in literature [7-11]. Authors who used other reference points other than ours in the measurement of the version of glenoid obtained values of the retroversion that are higher [12-16], which does not alter the approach given that eventual corrections are adapted to each patient. It seems the reference point on the body of the scapular is closest to real functional conditions of the glenoid as indicated by Budge [17], it for this reason that we chose this reference.

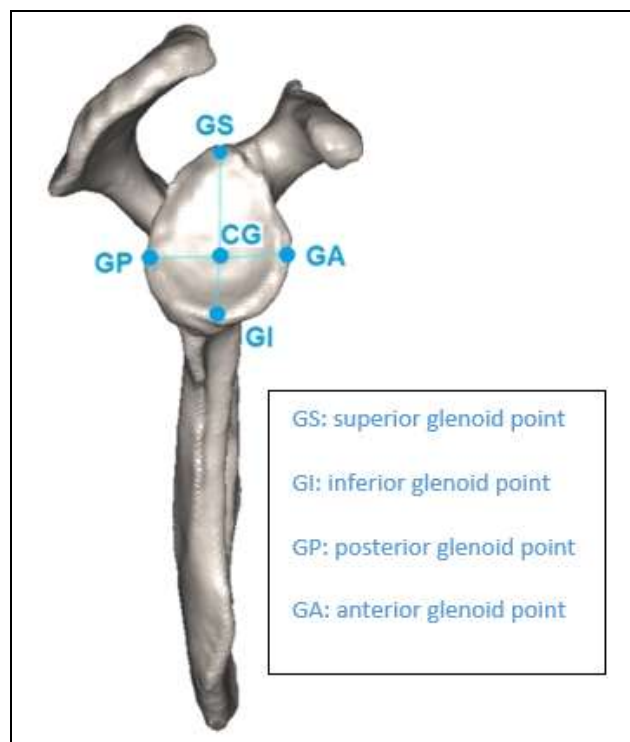


Fig 1: determination of center of the glenoid

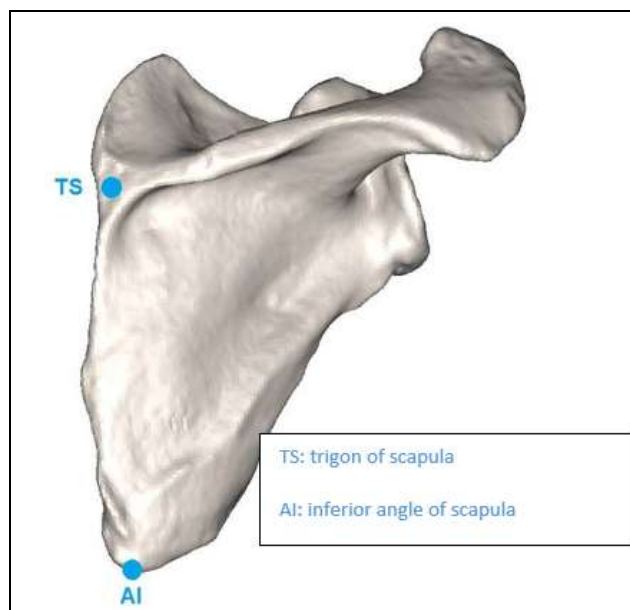


Fig 2: reference points on scapula

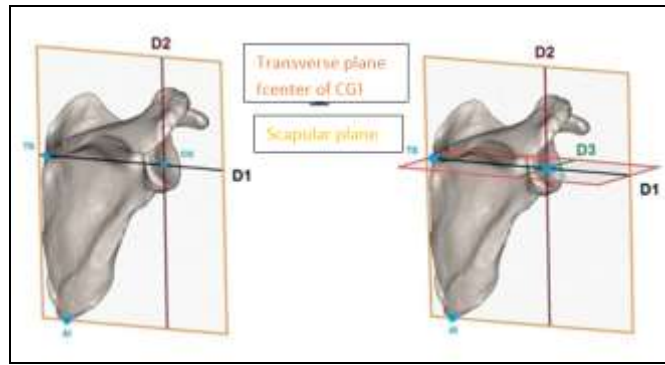


Fig 3: definition of the scapular plane and the transversal plane

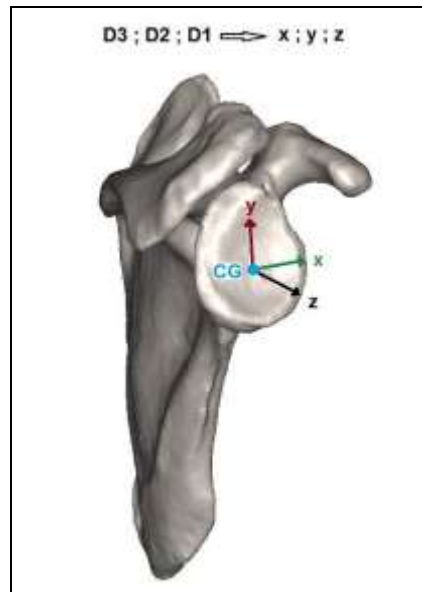


Fig 4: definition of glenoid landmarks

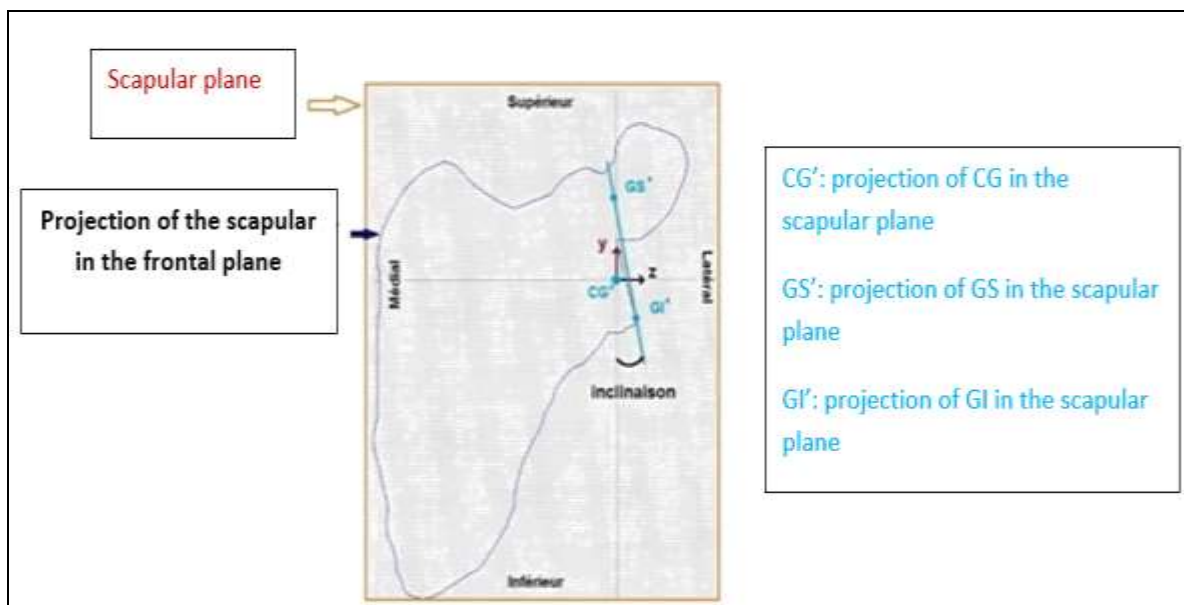


Fig 5: inclination of the glenoid

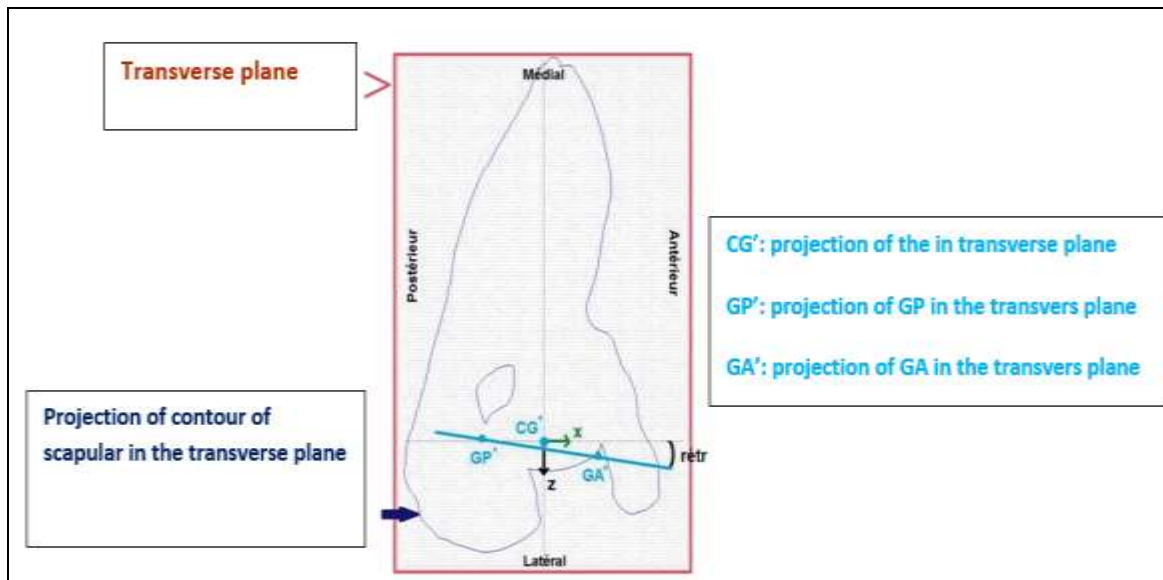


Fig 6: retroversion of the glenoid

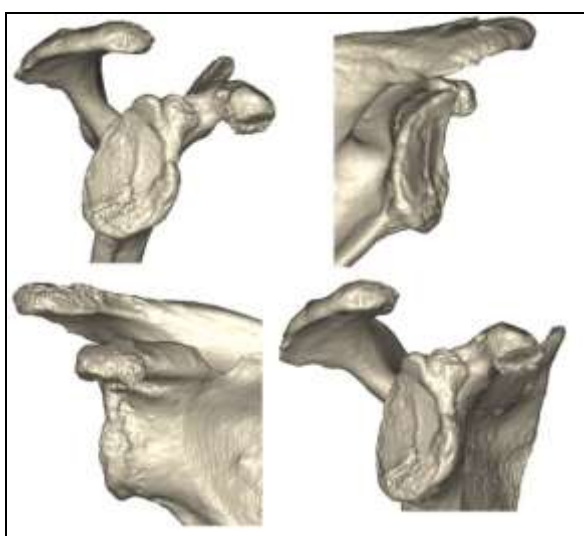


Fig 7: scan images of the glenoid of case n°1



Fig 8: planification of case n°1

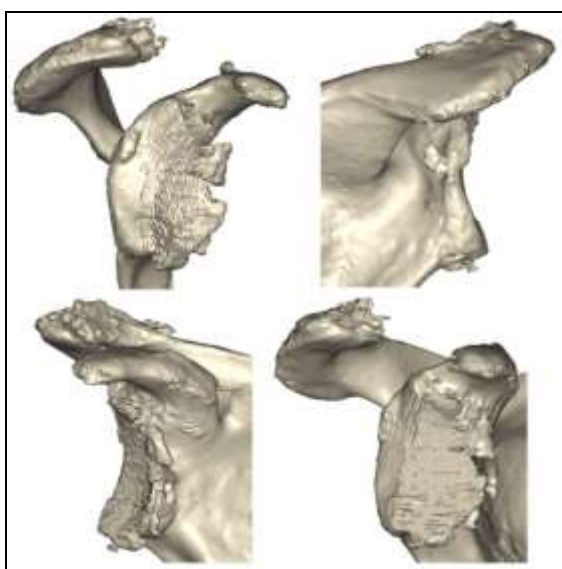


Fig 9: planification of case n°3

Conclusion

Thanks to the preoperative planification with use of CT scan, the correction of the orientation of the glenoid component can

be perfectly define. The planned version is obtained using a pre- sized ancillary fabricated for each patient. This method is particularly important in cases of major anomalies in the

orientation of the glenoid as it improves the precision (which is in the order of 1° from control post-operative CT scans realized in this study) in the position of the glenoid implant. Our conclusions permit us to expand our study by correlating the knowledge on the orientation of humeral implants with glenoid implants with the aid of the concept « Personal Fit3 »^[5] which simulates the cinematics of the preoperative shoulder with respect to the cinematics of the prosthetic shoulder.

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