AN EXPERIMENTAL STUDY OF THE EFFECT OF GLENOID IMPLANT DESIGN ON GLENOHUMERAL STABILITY

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INTRODUCTION
Glenohumeral stability, defined as humeral head translations, is a key point after shoulder arthroplasty. Indeed this parameter is one of the determining factors in the glenoid loosening since linked with the rocking horse effect [1].

In an intact shoulder, translations are controlled by all active and passive elements, especially the labrum [2]. In a prosthetic shoulder, translations are influenced by 2 features. The first is the surface congruence (also named conformity or mismatch) defined as the difference of curvature between the prosthetic head and glenoid; the second is the surface constraints linked with the glenoid prosthetic shape.

The objective of this study was also to compare biomechanical results of 2 glenoid components (Ceraver, Roissy, France): (1) a standard design and (2) a design named “labrum design” with a superior part simulating the anatomic labrum.

METHODS
An experimental device was developed to evaluate deltoid forces and kinematics. It simulates active, dynamic and continuous abduction of an entire arm. It reproduces the Scapulo-Humeral Rhythm. Two coordinate systems were created to evaluate the humeral head translations relative to the glenoid. A reproducibility protocol was performed on one intact specimen. The evaluated parameters in terms of means, standard deviation (SD) and Intra- and Inter-Class Coefficients (ICC) were the kinematics and the deltoid forces during abduction.

Five specimens were used to study the effect of the glenoid implant on the glenohumeral stability. The labrum design was installed first. To evaluate the effect of mismatch on the stability, 3 humeral heads were tested, corresponding to the ones recommended by the company and based on a previous study (5mm to 10mm) [3]. The experiment was repeated for the standard design.

RESULTS
The mean of maximal deltoid force was 360N with 10N SD. The mean of abduction was 77° with 2° SD. The maximal antero-posterior translations were 2.2mm with 0.41mm SD and maximal Inferior-Superior translations were 7.5mm with 0.3mm SD. All ICC were higher than 0.9, except for AP displacement (ICC = 0.70).

The study of the mismatch on the stability showed that largest displacements were associated with biggest mismatches. Nevertheless, differences between series were too small to conclude on the clinical effect of mismatch.

Figure 1 shows the pattern of the prosthetic head displacements for both standard and labrum glenoid designs for one specimen. This confirms the effect of the artificial labrum on stability, by decreasing the displacement and/or centring the prosthetic head with respect to the glenoid component.

DISCUSSION & CONCLUSIONS
A new experimental setup developed for shoulder biomechanics studies was used to conduct a proof of concept of the labrum design effect. The results showed that glenohumeral stability is influenced by the surface constraints, i.e. the glenoid shape and especially the artificial labrum.

Although other studies concluded on the effect of mismatch on the stability [4], no clinical effect was found in our study. However, it must be noted that other studies tested smaller mismatches (0mm to 6mm) than ours.

We could conclude that the artificial labrum can reduce the glenoid loosening risk by decreasing the humeral head translations and also the rocking horse effect.

The main limitation of this study is associated with the in vitro study and simulation of only abduction movements.

REFERENCES