A COMPARITIVE ASSESSMENT OF THE RANGE OF MOTION AND STABILITY ASSOCIATED WITH TWO DIFFERENT REVERSE SHOULDER DESIGNS

+*Roche, C; **Flurin, PH; ***Wright, T; ****Crosby, L; *Mauldin, M; *****Zuckerman, J
+ *Exactech, Gainesville, FL; ** Bordeau-Merignac Clinic, FR; ***Univ. of Florida Dept. of Ortho., Gainesville, FL; Wright State, Dayton OH; *****Hosp. for Joint Diseases, NY (352) 377-1140. Fax: (352) 378-2617. chris.roche@exac.com

Introduction
Reports of successful outcomes with reverse shoulder arthroplasty have led to an expansion of its indications and an increase in the number of reverse shoulder designs available in the marketplace, despite the well documented complication rates. Previous work has elucidated relationships between reverse shoulder design parameters and functional measurements (e.g. prosthesis inferior and superior impingement, range of motion (ROM), and jump distance).1 The purpose of this study is to apply the previously elucidated relationships to quantify and compare the range of motion and stability associated with two different reverse shoulder designs currently available in the marketplace.

Definitions
Inferior Impingement is defined as the humeral abduction at which point the medial portion of the humeral liner impinges on the scapula. Superior Impingement is defined as the humeral abduction at which point the lateral portion of the humeral liner impinges on the scapula.

Range of Motion is defined as the humeral abduction/adduction occurring between inferior and superior impingement. It should be noted that scapular rotation is not considered in this measurement; for comparative purposes, only humeral rotation is considered.

Jump Distance is a measure of inherent prosthesis stability and is defined as the lateral distance necessary for the glenosphere to escape from the humeral liner at varying degrees of abduction.

Humerus Constraint is defined as the ratio between humeral liner depth and width (at its face). For clarification, a constraint > 0.5 is a constrained joint.

Methods
Two reverse shoulder prostheses (36mm Grammont and the 38mm, 42mm, and 46mm Equinoxe; Exactech, Inc.) were geometrically modeled using 3-D computer-aided design software (Unigraphics; UGS, Inc.). The 36mm Grammont has a 155° neck angle, a humeral liner constraint of 0.275, and a 36x19mm glenosphere. The 38mm, 42mm, and 46mm Equinoxe have a 145° neck angle; a humeral liner constraint of 0.260, 0.250, and 0.240, respectively; and a glenosphere geometry of 38x21mm, 42x23mm, and 46x25mm, respectively. Additionally, a distal offset is built into each Equinoxe to provide 2.25mm, 4.25mm, and 6.25mm of distal glenosphere shift, respectively. After modeling, each prosthesis was then assembled to a 3-D digitized scapula; Zygote Media Group, Inc.) to create a functional glenohumeral joint. Prior to assembly, <2mm of bone was removed from the glenoid fossa of the digitized scapula to create a conforming surface for each implant; the glenoid component was implanted “slightly inferior to the center of the glenoid” simulating surgical preparation per the manufacturer’s technique. A geometric computer analysis was then conducted to quantify the inferior impingement, superior impingement, range of motion, and jump distance associated with each design during simulated humeral abduction/adduction in the scapular plane.

Results
The computer analysis demonstrated that the Grammont reverse shoulder design impinged inferiorly and superiorly on the glenoid at 30.75° and 95° of humeral abduction with an average jump distance of 10mm. (Figures 1 and 3) The computer analysis demonstrated that the 38mm, 42mm, and 46mm Equinoxe reverse shoulder designs impinged inferiorly and superiorly on the glenoid at 7.25°/87.5°, 1°/87.5°, and 0°/89.25° of humeral abduction with an average jump distance of 11.7mm, 13.5mm, and 14.1mm, respectively. (Figures 2 and 3)

Discussion and Conclusions
The results of this study demonstrate that the Grammont reverse shoulder design inferiorly impinges on the scapula prior to the patient being able to adduct his/her arm to their side, as is necessary during activities of daily living. Similar results have been verified radiographically and clinically.2,3 The comparative results associated with the Equinoxe reverse shoulder designs demonstrate that subtle variations in design parameters can have dramatic and meaningful improvements in both ROM (39%) and jump distance (36%).

Figure 1. Grammont Reverse Shoulder ROM
Figure 2. Equinoxe Reverse Shoulder ROM
Figure 3. Comparative Assessment of ROM and Jump Distance Associated with each Reverse Shoulder Design

References