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ASSESSMENT OF LINER MOVEMENT ON DUAL MOBILITY CUP: PRELIMINARY EX VIVO STUDY

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Introduction

The concept of the Dual Mobility Cup (DMC) was developed, in 1974, by G. Bousquet [1]. This hip prosthesis is composed of two joints : a large one, between the metallic cup and the polyethylene liner, and a small one between the femoral head and the polyethylene liner. Compared to standard prosthesis, this design helps to restore the hip joint range of motion, decrease wear, and increase implant stability [3].

The way this prosthesis moves in vivo has not been established yet. Therefore, this study aims at visualizing and quantifying the liner movement in ex vivo experiments, for different leg movements. Ultrasound imaging is used as it is non-invasive, and has already been used to visualize the liner movement in vitro (on immersed DMC) [2].

Methods

A DMC (Serf Novae®) was implanted on a cadaveric subject (male, 78 years old). Six intracortical pins with reflective markers tripods were fixed in the pelvis, left femur and tibia. One rigid tripod was fixed on a 3D ultrasound probe (SuperLinear™ Volumetric SLV16-5). Hip joint range of motion (RoM) was applied manually and recorded using Optitrack (NaturalPoint, Inc.). Ultrasound acquisitions were performed, in a series of static poses, using the 3D probe and an ultrasound system (Aixplorer® Supersonic Imagine®).

Hip kinematics and ultrasound imaging position were obtained using motion analysis data (Figure 1). Liner spherical surface and plane were segmented on the ultrasound imaging data using 3D Slicer. Thanks to these data, change of abduction and anteversion angle of the liner plane, relative to the pelvis, were calculated for different movements using MATLAB (MathWorks®).

Results

Hip movement	RoM (°)	Abduction (°)	Anteversion (°)
Flexion	20.6	8.5	-5.6
Abduction	14.8	-5.7	-7.1
Adduction	5.0	6.9	0.7
Internal rotation	12.9	5.1	-2.8
External rotation	30.2	-7.9	9.0

Table 1: Change of abduction and anteversion angle of the liner plane after hip movement (RoM and angles in degrees)

No clear tendency was found between hip joint and liner plane angles. However, at the end of a series of static poses starting and going back to neutral posture, the liner did not return to its initial orientation (Table 1).

Biomechanical data show a greater liner movement for flexion, external rotation and hip abduction (abduction and anteversion angle greater than 5°), while 5° of hip adduction produce a small anteversion movement (anteversion angle less than 1°).

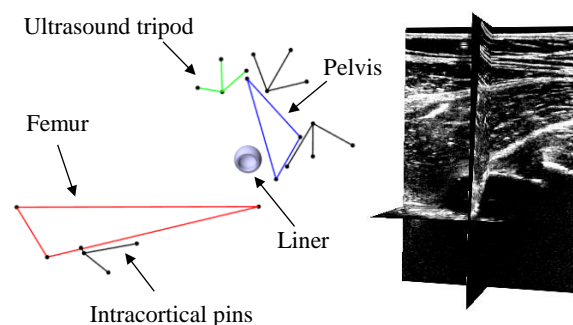


Figure 1: Liner position using fused data (left) – 3D ultrasound imaging (right)

Discussion

This preliminary ex vivo study showed that the liner movement could be quantified and visualised using ultrasound imaging. This result is promising for future in vivo studies, where we expect muscular activity to also affect liner movement. Moreover, even though the study was conducted on only one subject and only for small RoM because of the probe size positioned on the groin area, liner movement could still be observed. The amount of liner movement is not negligible, but remains under 10° of amplitude. Therefore, further experiments should be carried out to better understand the liner movement, and identify movement patterns.

References

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