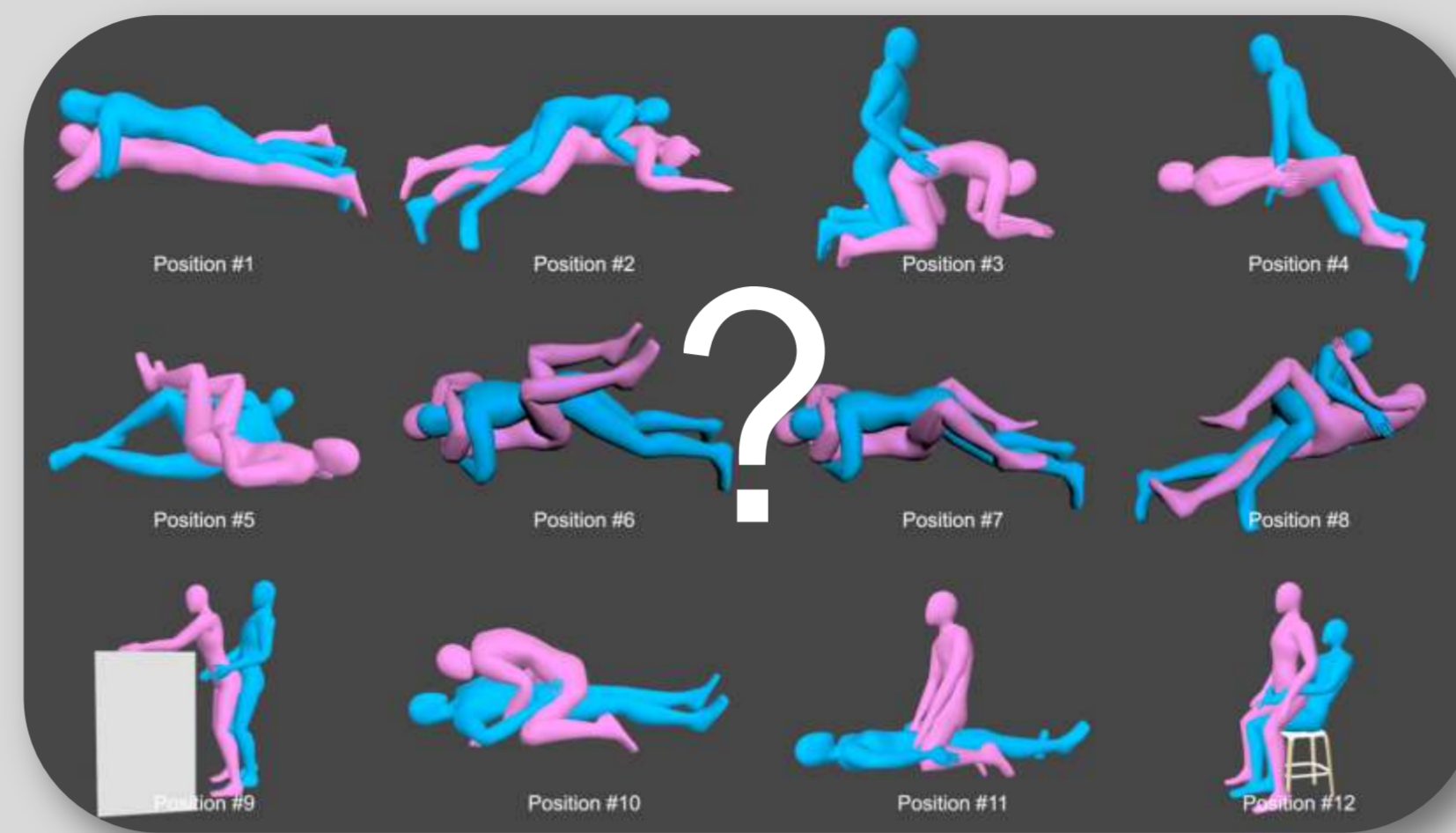
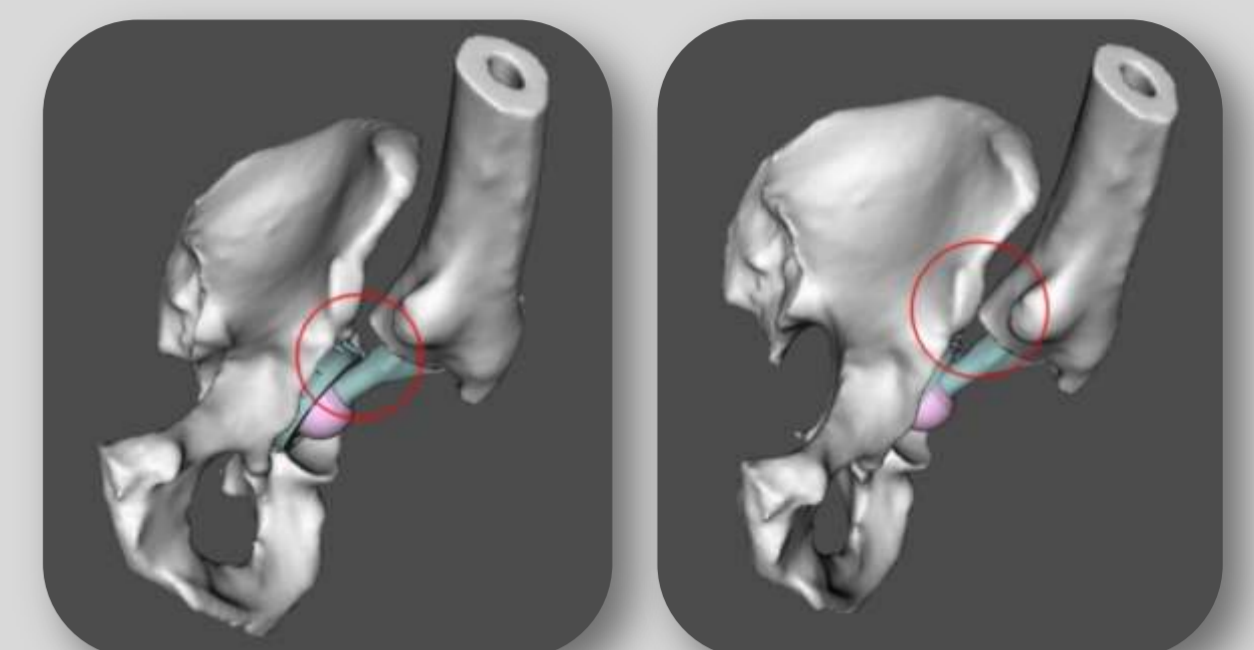


Objectives

- What are the risk of sexual activity after Total Hip Arthroplasty (THA)?
 - Topic rarely discussed between patients and surgeons
 - No objective data allowing clear identification of sexual positions potentially at risk
- What is the hip range of motion (ROM) required to perform such activity?
 - A dynamic study of the hip joint during sexual positions has never been performed
- Goals of the study:
 - Obtain *realistic motion data* for several common sexual positions and to objectively evaluate the *relative risk of impingements and joint instability* during their practice
 - Provide surgeons with *specific instructions* to patient's inquiries



The 12 common sexual positions tested in this study

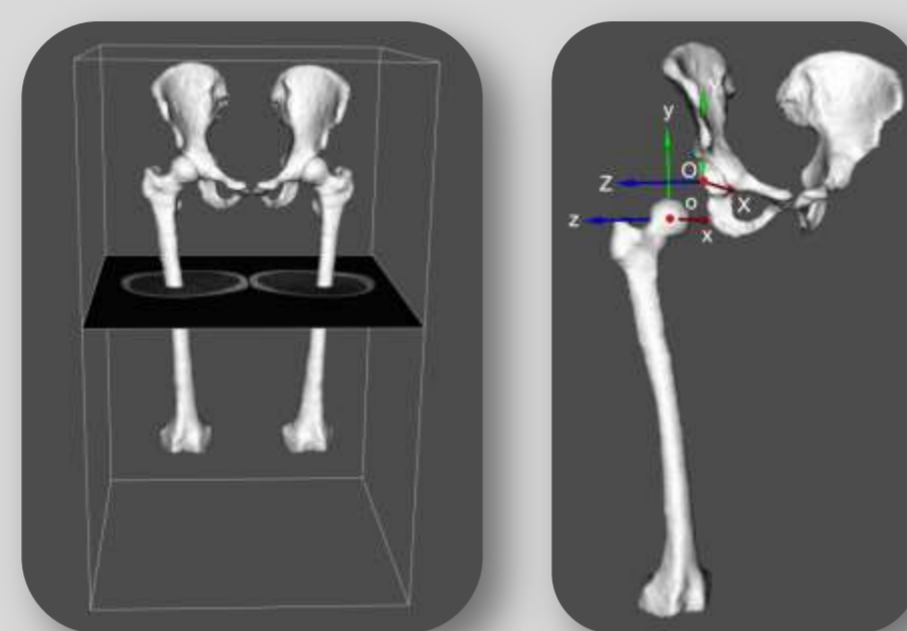


Component and bony impingements

Material and Methods

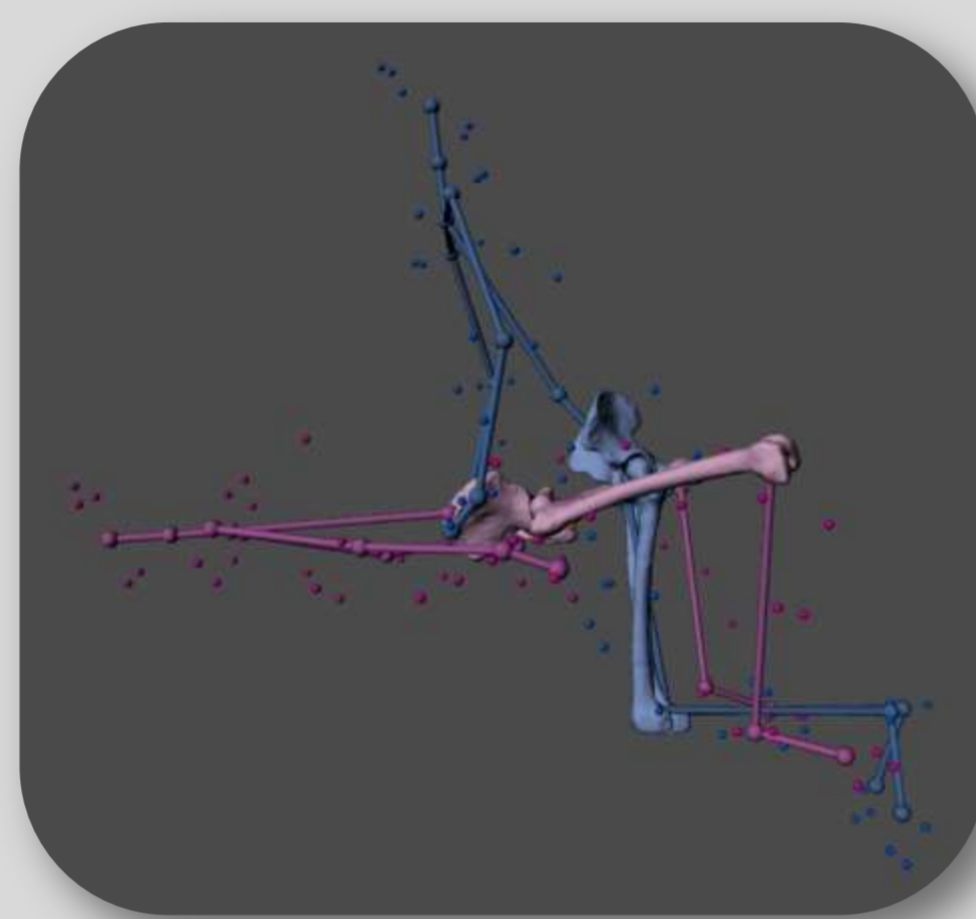
1 Data Acquisition

- Motion capture and MRI was carried out on two healthy volunteers (1♂, 1♀)
 - 3D models of the pelvis and femur were reconstructed from MRI data [1]. Bone coordinate systems were computed according to ISB recommendations [2] to report joint motion in a standardized way.
 - 12 common sexual positions were captured using a Vicon MXT40S system (24 cameras, sampling: 120 Hz).



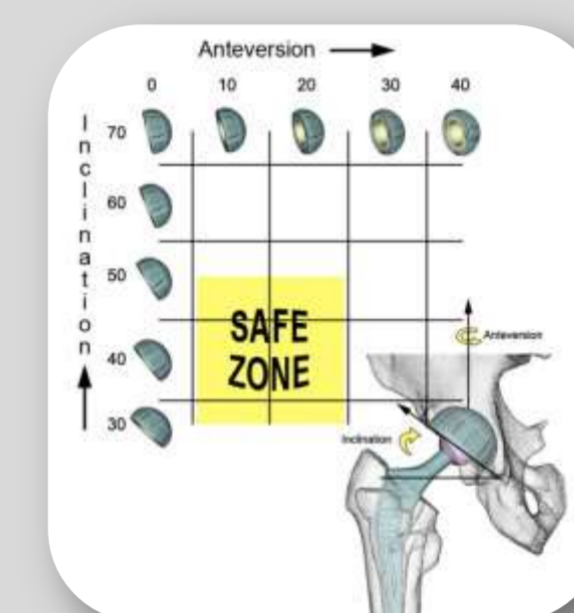
2 Joint Kinematics and ROM Computation

- The hip joint kinematics was computed from the recorded markers trajectories using a validated optimized fitting algorithm which accounted for skin motion artifacts (errors: ≈ 0.5 mm, $< 3^\circ$) [3,4].
- Given the computed bone positions from motion capture data and thanks to the bone coordinate systems, the relative orientation between the pelvis and femur was determined at each point of the movement and expressed in clinical terms (flex/ext, abd/add, IR/ER).

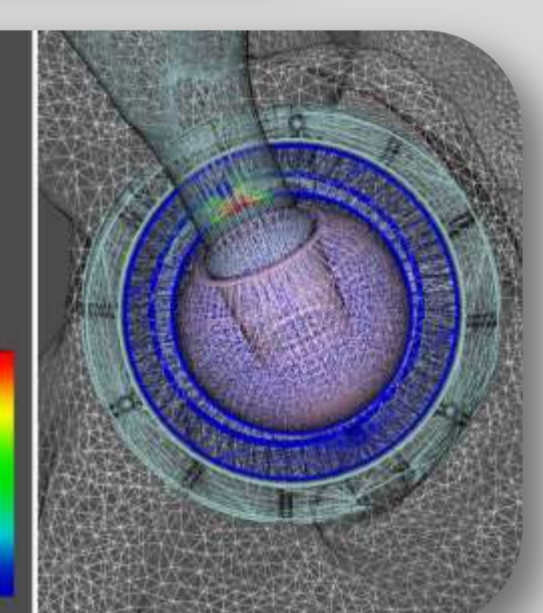
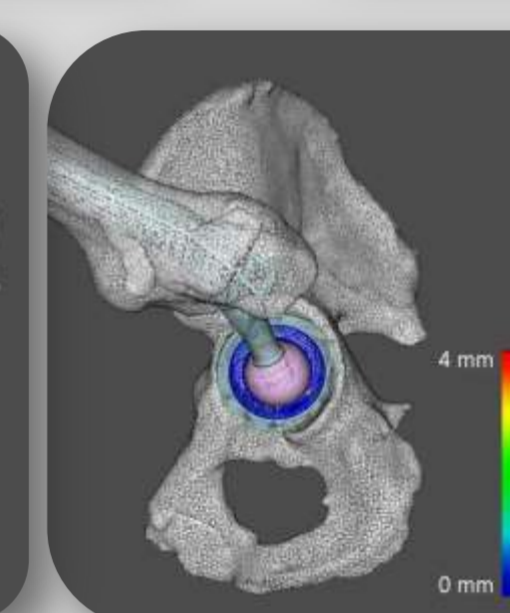
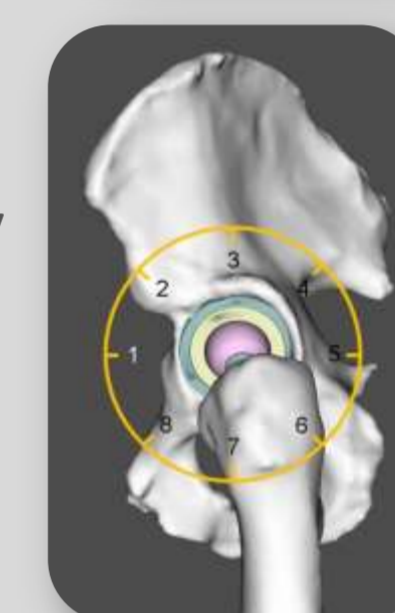


3 Simulation of Prosthetic Hip 3D Models and Risk Assessment

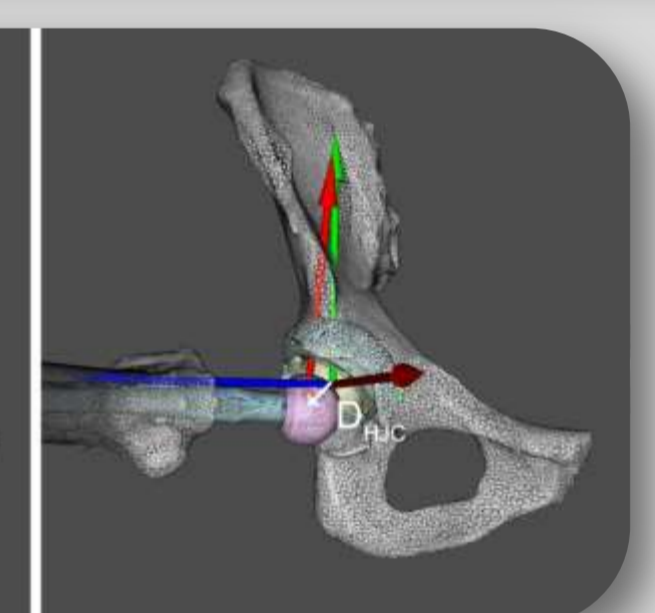
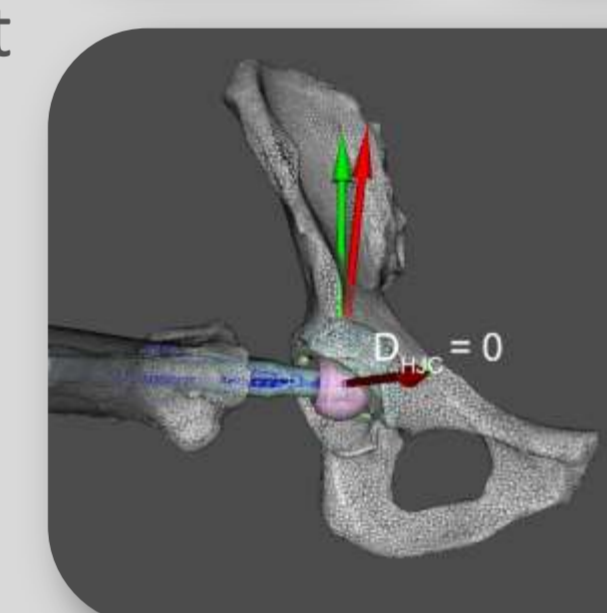
- The captured motions were applied to prosthetic hip 3D models including 9 cup configurations (inclination: 40° , 45° , 60° and anteversion: 0° , 15° , 30°). Femoral anteversion was neutral with the stem being parallel to the posterior cortex.
- Bony and prosthetic impingements were automatically detected in real-time over the full range of motion using a collision detection algorithm [3,4,5].
- To describe and document the exact location of the impingement zone, the acetabulum was divided into 8 sectors.
- Femoral head translations (subluxation) were also computed to evaluate the joint congruence.



Prosthetic hips developed using CAD software with variations of cup positioning



Visualization of the impingement zone (blue = no contact, red = highest contact)



Definition of joint congruence: the vector D_{HIC} determined the amount and direction of subluxation

Results

1 Hip ROM

- Sexual positions for women required intensive flexion (4 positions with $> 95^\circ$), abduction (4 positions with $> 32^\circ$) and mostly external rotation.
- For men positions, flexion and abduction remained in the normal range, but external rotation was dominant for all motions.

Movements	Flex	Abd	IR/ER
Position #1	$5^\circ \pm 3.5^\circ$	$16^\circ \pm 0.7^\circ$	$0/18^\circ \pm 4.2^\circ$
Position #2 (right leg)	$74^\circ \pm 2.1^\circ$	$14^\circ \pm 1.6^\circ$	$0/16^\circ \pm 3.9^\circ$
Position #2 (left leg)	$13^\circ \pm 0.5^\circ$	$1^\circ \pm 4.1^\circ$	$0/13^\circ \pm 2.8^\circ$
Position #3	$96^\circ \pm 3.5^\circ$	$27^\circ \pm 2.1^\circ$	$0/2^\circ \pm 0.7^\circ$
Position #4	$22^\circ \pm 2.8^\circ$	$35^\circ \pm 6.4^\circ$	$0/20^\circ \pm 1.4^\circ$
Position #5	$108^\circ \pm 5.7^\circ$	$6^\circ \pm 17.7^\circ$	$0/9^\circ \pm 2.1^\circ$
Position #6	$100^\circ \pm 3.5^\circ$	$26^\circ \pm 0.7^\circ$	$0/7^\circ \pm 1.4^\circ$
Position #7	$56^\circ \pm 3.5^\circ$	$34^\circ \pm 2.8^\circ$	$0/4^\circ \pm 6.4^\circ$
Position #8 (right leg)	$4^\circ \pm 1.1^\circ$	$10^\circ \pm 5.3^\circ$	$9/0^\circ \pm 4.2^\circ$
Position #8 (left leg)	$82^\circ \pm 2.4^\circ$	$29^\circ \pm 2.5^\circ$	$5/0^\circ \pm 4.1^\circ$
Position #9	$45^\circ \pm 4.2^\circ$	$7^\circ \pm 2.8^\circ$	$0/9^\circ \pm 1.4^\circ$
Position #10	$95^\circ \pm 6.4^\circ$	$35^\circ \pm 2.1^\circ$	$4/0^\circ \pm 4.2^\circ$
Position #11	$49^\circ \pm 2.1^\circ$	$26^\circ \pm 1.4^\circ$	$17/0^\circ \pm 9.9^\circ$
Position #12	$70^\circ \pm 4.2^\circ$	$32^\circ \pm 1.4^\circ$	$0/15^\circ \pm 2.1^\circ$

Table 1: Hip ROM ($^\circ$) during sexual positions for women

Movements	Flex/Ext	Abd/Add	ER
Position #1	$1^\circ/0^\circ \pm 2.8^\circ$	$1^\circ/0^\circ \pm 11.3^\circ$	$34^\circ \pm 7.8^\circ$
Position #2 (right leg)	$82^\circ/0^\circ \pm 1.5^\circ$	$32/0^\circ \pm 2.3^\circ$	$21^\circ \pm 4.6^\circ$
Position #2 (left leg)	$3^\circ/0^\circ \pm 1.2^\circ$	$4^\circ/0^\circ \pm 1.5^\circ$	$34^\circ \pm 4.6^\circ$
Position #3	$37^\circ/0^\circ \pm 5.7^\circ$	$8^\circ/0^\circ \pm 10.6^\circ$	$14^\circ \pm 8.5^\circ$
Position #4	$30^\circ/0^\circ \pm 2.1^\circ$	$0/4^\circ \pm 16.3^\circ$	$6^\circ \pm 7.8^\circ$
Position #5 (right leg)	$39^\circ/0^\circ \pm 5.4^\circ$	$18^\circ/0^\circ \pm 3.2^\circ$	$9^\circ \pm 4.2^\circ$
Position #5 (left leg)	$14^\circ/0^\circ \pm 2.4^\circ$	$0/17^\circ \pm 3.1^\circ$	$41^\circ \pm 4.5^\circ$
Position #6	$23^\circ/0^\circ \pm 0.7^\circ$	$15^\circ/0^\circ \pm 4.9^\circ$	$40^\circ \pm 3.5^\circ$
Position #7	$17^\circ/0^\circ \pm 1.4^\circ$	$5^\circ/0^\circ \pm 9.9^\circ$	$30^\circ \pm 7.1^\circ$
Position #8 (right leg)	$76^\circ/0^\circ \pm 5.8^\circ$	$21^\circ/0^\circ \pm 5.2^\circ$	$37^\circ \pm 6.0^\circ$
Position #8 (left leg)	$6^\circ/0^\circ \pm 7.1^\circ$	$0/14^\circ \pm 5.0^\circ$	$47^\circ \pm 3.7^\circ$
Position #9	$22^\circ/0^\circ \pm 6.4^\circ$	$0/1^\circ \pm 5.7^\circ$	$4^\circ \pm 9.2^\circ$
Position #10	$0/10^\circ \pm 2.1^\circ$	$0/2^\circ \pm 9.9^\circ$	$18^\circ \pm 4.2^\circ$
Position #11	$3^\circ/0^\circ \pm 0.7^\circ$	$1^\circ/0^\circ \pm 9.9^\circ$	$42^\circ \pm 17.0^\circ$
Position #12	$44^\circ/0^\circ \pm 5.7^\circ$	$2^\circ/0^\circ \pm 4.9^\circ$	$11^\circ \pm 14.1^\circ$

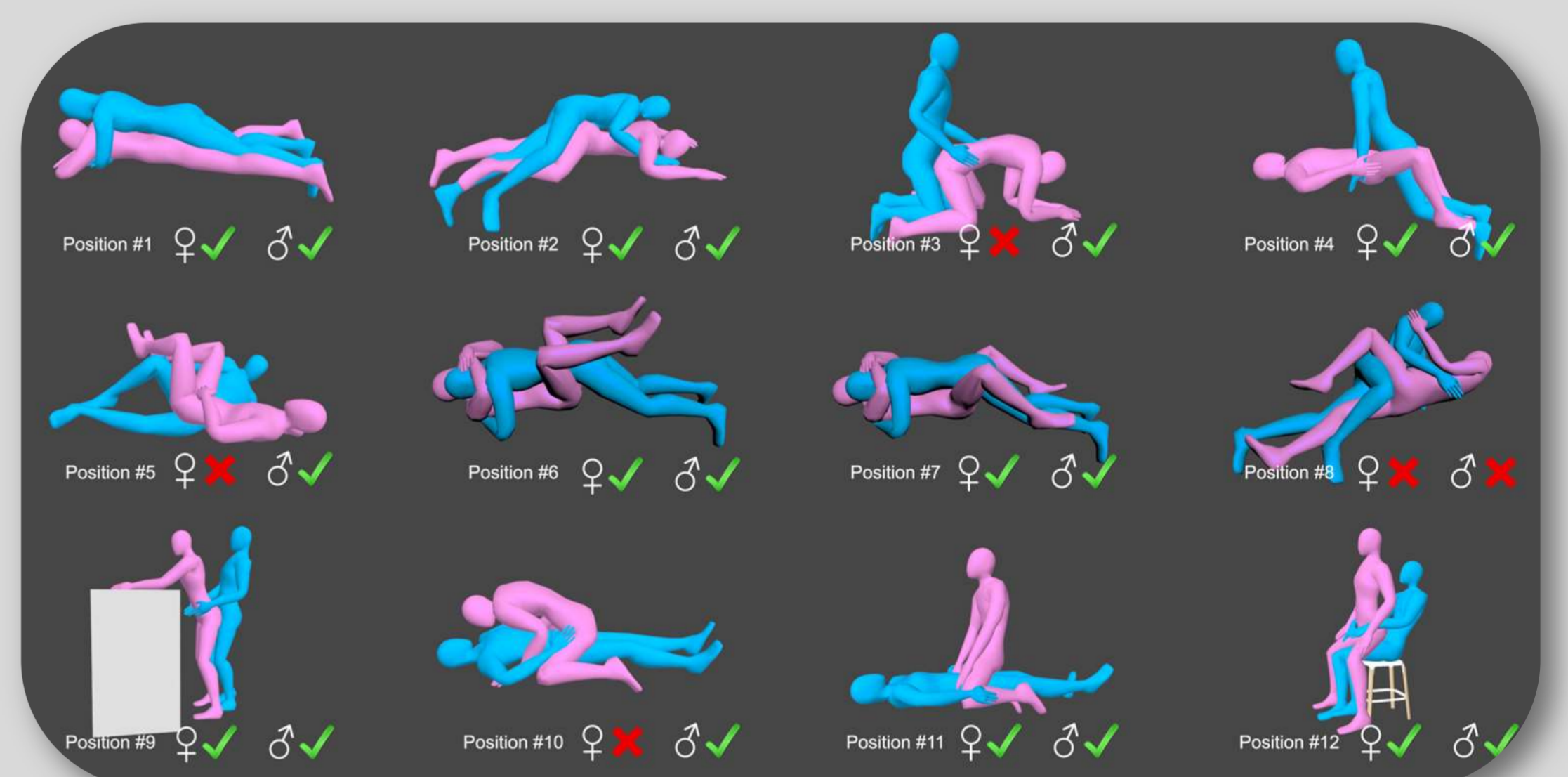
Table 2: Hip ROM ($^\circ$) during sexual positions for men

2 Impingements and Joint Instability

- For women:
 - Prosthetic impingements occurred during the 4 positions requiring the highest flexion at 6 cup positions (no collision at cups $45^\circ/30^\circ$, $60^\circ/15^\circ$, $60^\circ/30^\circ$).
 - Contacts were located in the anterosuperior or superior area of the acetabulum and subluxation was posterior (range: 1.14 – 5.12 mm).
- For men:
 - Bony impingements occurred during one sexual position at all cup positions.
 - Contacts were located in the posteroinferior area of the acetabulum and subluxation was anterior (range: 0.51 – 4.99 mm).

Conclusion

1 Recommendations after THA



2 Other Conclusions

- Sexual positions for women require intensive hip ROM (flexion and abduction)
- Sexual positions for men require less mobility (but with pronounced external rotation)
- Sexual activity could expose the patients after THA to impingement associated with joint instability
 - The conclusions should be useful for surgeons when advising patients as to sexual positions that may be practiced after THA

References

- [1] J. Schmid, J. Kim, N. Magnenat-Thalmann, "Robust statistical shape models for MRI bone segmentation in presence of small field of view", *Med Image Anal*, 15:155-168, 2011.
- [2] G. Wu, S. Siegler, P. Allard, C. Kirtley, A. Leardini et al., "ISB recommendation on definitions of joint coordinate system of various joints for the reporting of human joint motion - part I: Ankle, hip and spine", *J Biomech*, 35(4):543-548, 2002.
- [3] C. Charbonnier, L. Assassi, P. Volino, and N. Magnenat-Thalmann, "Motion study of the hip joint in extreme postures", *Vis Comput*, 25(9):873-882, 2009.
- [4] C. Charbonnier, F.C. Kolo, V. Duthon, N. Magnenat-Thalmann, C.D. Becker, P. Hoffmeyer, and J. Menetrey, "Assessment of congruence and impingement of the hip joint in professional ballet dancers", *Am J Sports Med*, 39(3):557-566, 2011.
- [5] C. Charbonnier, S. Chagué, M. Ponzoni, M. Bernardoni, P. Hoffmeyer, and P. Christofilopoulos, "Sexual Activity after Total Hip Arthroplasty: A Motion Capture Study", *J Arthroplasty*, 29(3):640-647, 2014.