Sexual Activity after Total Hip Arthroplasty: A Motion Capture Study

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Abstract

Relative risk of impingement and joint instability during sexual activities after total hip arthroplasty (THA) has never been objectively investigated. Hip range of motion necessary to perform sexual positions is unknown. A motion capture study with two volunteers was performed. 12 common sexual positions were captured and relevant hip joint kinematics calculated. The recorded data was applied to prosthetic hip 3D models to evaluate impingement and joint instability during motion. To explore the effect of acetabular component positioning, nine acetabular cup positions were tested. Four sexual positions for women requiring intensive flexion (> 95°) caused prosthetic impingements (associated with posterior instability) at 6 cup positions. Bony impingements (associated with anterior instability) occurred during one sexual position for men requiring high degree of external rotation (> 40°) combined with extension and adduction at all cup positions. This study hence indicates that some sexual positions could be potentially at risk after THA, particularly for women.

Keywords

Total hip arthroplasty, sexual activity, motion capture, impingement, joint instability, cup positioning

Introduction

Hip pain occurring in the settings of osteoarthritis or dysplasia has been recognized as a cause of sexual difficulty [1-4]. In a high numbers of patients, total hip arthroplasty (THA) has been reported to have beneficial effects in restoring sexual satisfaction and performance [1-3, 5, 6]. Even though, many wonder about the risks related to sexual activity after THA, and this issue remains rarely discussed between patients and surgeons.

A few numbers of studies have examined sexual function before and after THA [2, 3, 5-7]. These studies used patient or surgeon questionnaires to gather information related to sexual difficulties before and after THA, return to sexual activity, and safety of sexual positions. Some of them [3, 7] also mentioned a few cases of dislocation during sexual intercourse, but no attempt was made to determine details such as hip position during dislocation. To date, the risk of impingement and joint instability during sexual activities has therefore not been particularly investigated. In the article of Dahm et al. [7], recommendations were made about sexual positions that should be avoided, but they were based solely on the surgeon's personal appreciation. Thus, there exists presently no objective data that allows clear identification of sexual positions potentially at risk.

Computer simulation of prosthetic hip joint 3D models to estimate relative risk of component and bony impingement, as well as dislocation during activities of daily living has been well documented [8-10]. However, such data regarding sexual activities is missing. One reason that might explain this lack of information is that to our knowledge, a dynamic study of the hip joint during sexual positions has never been performed, so that kinematic data is not available for testing and simulation. The range of motion (ROM) of the hip joint necessary to execute such positions is also unknown.

The purpose of this research was to obtain realistic motion data for several common sexual positions and to objectively evaluate relative risk of impingement and joint instability during their practice. We therefore conducted an in-vivo study using optical motion capture and magnetic resonance imaging (MRI) in order to accurately determine hip joint kinematics during sexual activity. The data obtained was coupled to computer simulations of prosthetic hip joint 3D models to assess joint instability and prevalence of impingements.

Materials and Methods

In-Vivo Hip Joint Kinematics

Motion capture and MRI of the hip joint were carried out on two volunteers (1 female, 1 male). The age, weight, height and body mass index of the two subjects were 31 and 26 years, 180 and 180 cm, 69 and 80 kg, and 21.3 and 24.7 kg/m^2, respectively. Young healthy subjects were chosen for two reasons: 1) patients undergoing THA are becoming younger and are therefore sexually more active; 2) sexual positions being at risk, inclusion of healthy subjects was hence preferable to avoid any incident during motion capture. The subjects had no previous hip injuries, any kind of groin or back pain, hip surgery or contraindications for MRI. Informed consent was obtained prior to data collection.

The two volunteers were first MRI scanned with a 1.5 T HDxT system (General Electric Healthcare, Milwaukee, USA). MRI was privileged over Computed Tomography (CT) imaging, because it is not invasive. A flexible surface coil was used and the images were acquired in the supine position. The imaging protocol was issued from a previous study [11] that allowed for the acquisition of images suitable for both radiologic analysis and bone model reconstruction. The region of interest of MRI datasets extended from the L4 vertebra to the knee. Based on the 3D MR images, virtual 3D models of the hip joint were reconstructed using a validated segmentation software (mean ± standard deviation reconstruction error: 1.25 ± 1.0 mm) [12]. Thus, patient-specific 3D models of the pelvis and femur were reconstructed for each volunteer.

A musculoskeletal radiology specialist evaluated all images to assess any bony abnormalities, such as hip dysplasia or cam/pincer morphology. The morphological analysis included the following radiographic criteria: acetabular depth [13], acetabular version [14], lateral center edge (CE) angle [15], anterior CE angle [16], femoral head-neck alpha angle [17], neck-shaft angle [18] and femoral neck anteversion [19].

After MR imaging, the two volunteers participated in a motion capture session. They were equipped with spherical retroreflective markers (14 mm diameter) placed directly onto the skin using double sided adhesive tape. Two clusters of six markers were placed on the lateral and frontal parts of both thighs; six markers were also stuck on pelvic anatomical landmarks (e.g., anterior superior iliac spines). Additional markers were distributed over the body to confer a more complete visualization from general to detailed.

The volunteers were asked to perform 12 common sexual positions (Fig. 1). These 12 positions were the same as those used in the articles published by Lafosse et al. [2] and Dahm et al. [7]. All positions were considered as symmetric in terms of range of motion of both legs, except positions #2, #5 and #8 for men and positions #2 and #8 for women. The volunteers were asked to simulate the motion and each position was performed three times. Marker data was captured within a 108 m^3 measurement volume (6 x 6 x 3 m) using 24 infrared cameras (Vicon MXT40S, Oxford Metrics, UK), sampling at 120 Hz. A mattress was utilized and a standard 45 cm height stool was used for the position requiring a chair.

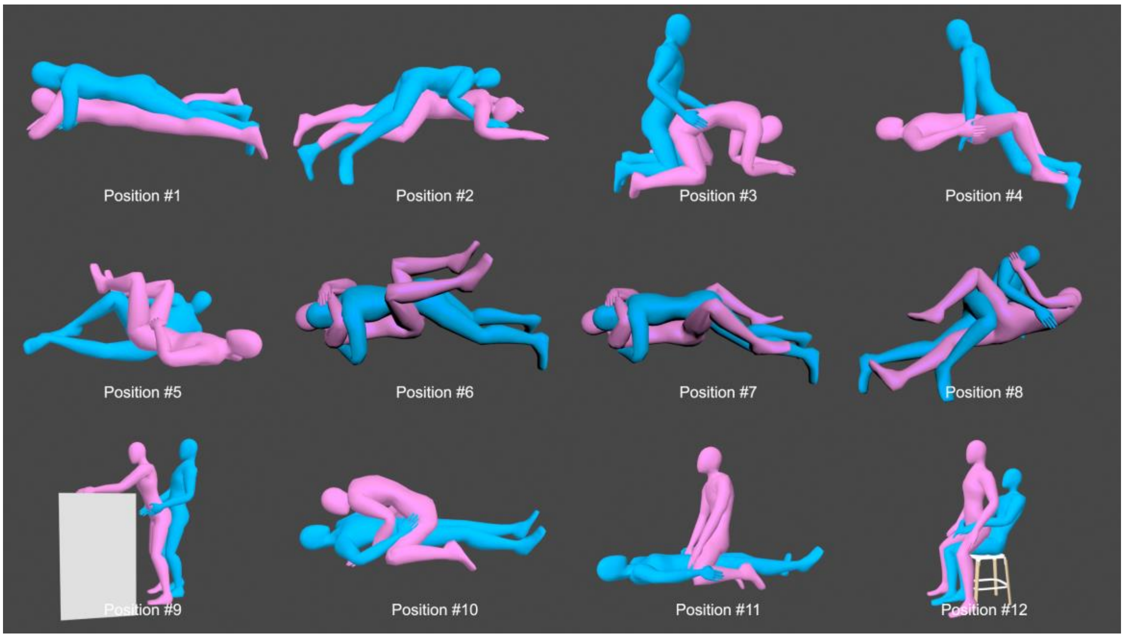

Fig 1. The twelve common sexual positions used in this study. In all images, the man is represented in blue and the woman in pink.

Hip joint kinematics was computed from the recorded markers' trajectories. 3D poses (position and orientation) of the pelvis and femur were calculated using a validated optimized fitting algorithm (translational error ≈ 0.5 mm, rotational error < 3°) [20, 21] that accounted for soft tissue artifacts (i.e., one of the major source of errors in skin marker-based joint motion analysis [22]) and patient-specific anatomical constraints. Indeed, the computed motions were applied to the subject's hip joint 3D models reconstructed from their MRI data, which allowed accounting for the subject's anatomy and kinematics parameters (e.g., hip joint center). Figure 2 shows examples of computed postures. A ball and stick representation of the overall skeleton was also added to improve the analysis and visualization of the motion.

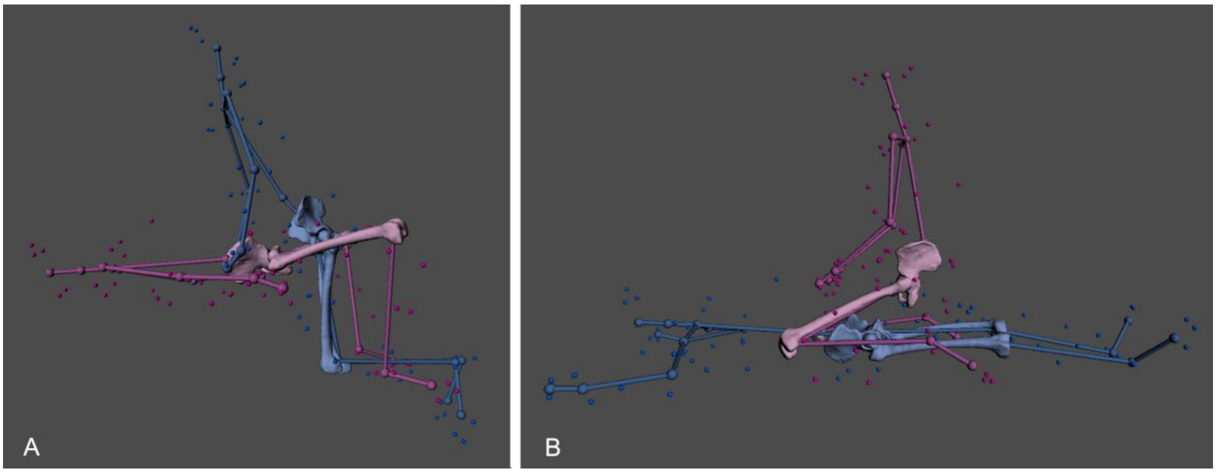

Fig 2. Example of computed sexual positions showing the markers (small spheres) and the virtual skeletons: A) Position #4 B) Position #11. In both images, the man is represented in blue and the woman in pink.

The hip ROM was quantified for each volunteer's hip during all 12 sexual positions. This was calculated using the subject's bony 3D models and two coordinate systems (one for the pelvis and one for the femur). The two coordinate systems were build according to the definitions proposed by the Standardization and Terminology Committee of the International Society of Biomechanics [23] (Fig. 3) using selected anatomical landmarks defined on the reconstructed surface of the subject's hip and femur bones. The same bone models were used to compute the hip joint center (HJC) position using a functional method [24]. This center was taken as the origin of the two coordinate systems. In the neutral position and orientation, the pelvic and femoral frames were aligned. Thus, given the computed bones poses from motion capture data, the relative orientation between the pelvis and femur was determined at each point of the movement [21]. This was finally expressed in clinically recognizable terms (flex/ext, abd/add and IR/ER) by decomposing the relative orientation into three successive rotations [25]. It is important to note that the computations were performed independently of the major anatomical planes (i.e., sagittal, transverse, frontal planes).

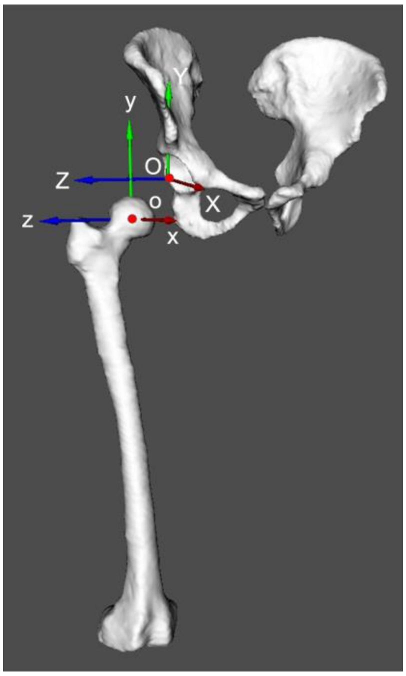

Fig 3. The pelvic coordinate system (XYZ) and the femoral coordinate system (xyz) for the right hip joint.

Simulation of Prosthetic Hip Joint 3D Models

The next step was to apply the computed kinematic data to prosthetic hip models, in order to evaluate relative risk of impingement and joint instability from the recorded movements. To this aim, a three-dimensional CAD model of the pelvis and femur with hip arthroplasty implants was developed using CAD software (SolidWorks, Concord, MA). Bone geometry was obtained from a three-dimensional reconstruction of a pelvic CT in a patient undergoing hip arthroplasty. Acetabular and femoral implants were modeled according to a standard commercial design (Medacta International, Castel San Pietro, Switzerland). The femoral component was implanted respecting the natural anteversion of the femur being parallel to the posterior cortex of the femoral neck. The diameter of the femoral head was 28 mm, the size of the acetabular cup was 48 mm and the polyethylene surface of the liner was hemispherical. To explore the effect of acetabular component positioning, nine acetabular cup positions (combinations of 40°, 45° and 60° of inclination with 0°, 15° and 30° of anteversion) were chosen, including and extending beyond the conventional "safe zone" of 30°-50° of inclination and 5-25° of anteversion [26].

Coordinate systems were established for the pelvis and femur based upon anatomical landmarks. They were created according to the same definitions as those used for the in-vivo study. The pelvic frame was also the basis for definition of cup inclination and anteversion. With the cup face initially on the transverse plane and the pole aligned with the Y axis, inclination was first achieved by rotating around the X axis and anteversion was then obtained by rotating about the Y axis.

Simulation was executed with custom-made software that required kinematic data input to permit rotational movement of the femoral component. Hip angles (3 rotations) computed from motion capture data were hence applied at each time step to the prosthetic model in its anatomical frame. The 12 common sexual positions for men and women (left and right hip motion) were examined, thus a total of 48 simulations were performed for each cup position.

Evaluation of Impingement and Joint Instability

We determined whether or not impingement occurred for each motion challenge and in every cup position. While running the simulation, a collision detection algorithm [20, 21] was used to virtually locate prosthetic and bony impingements. Moreover, a color scale was employed to document area of increased contact. This was evaluated by calculating the surface-to-surface distance between two colliding models (Fig. 4A). The blue color was assigned when no collisions were detected (surface-to-surface distance <= 0), while other colors showed the impingement zone. The red color denoted the area with the highest contact (surface-to-surface distance = max).

When impingement occurred, the hip ROM was noted down. To describe and report the exact location of the impingement zone, the acetabulum was divided into 8 sectors (position 1, anterior; position 2, anterosuperior; position 3, superior; position 4, posterosuperior; position 5, posterior; position 6, posteroinferior; position 7, inferior; position 8, anteroinferior), as depicted in Figure 4B. The impingement zones were hence assigned numbers correlating with their position.

Joint instability was calculated using the collision detection algorithm [20, 21]. In case of collision between the articulating components or bones, the positions of the femur and femoral component were corrected in order to reach the non-penetrating state. This correction corresponded to a translation of the HJC of vector $\mathbf{D}_{\mathbf{HJC}}$ (Fig. 5). Since no loads were applied to the joint, this translation should therefore be viewed as only representative of joint instability or subluxation rather than dislocation. Direction of vector $\mathbf{D}_{\mathbf{HJC}}$ also provided information about the direction of the subluxation. Since most sexual positions for men and women required hip flexion, joint instability was presumed to arise mainly posteriorly.

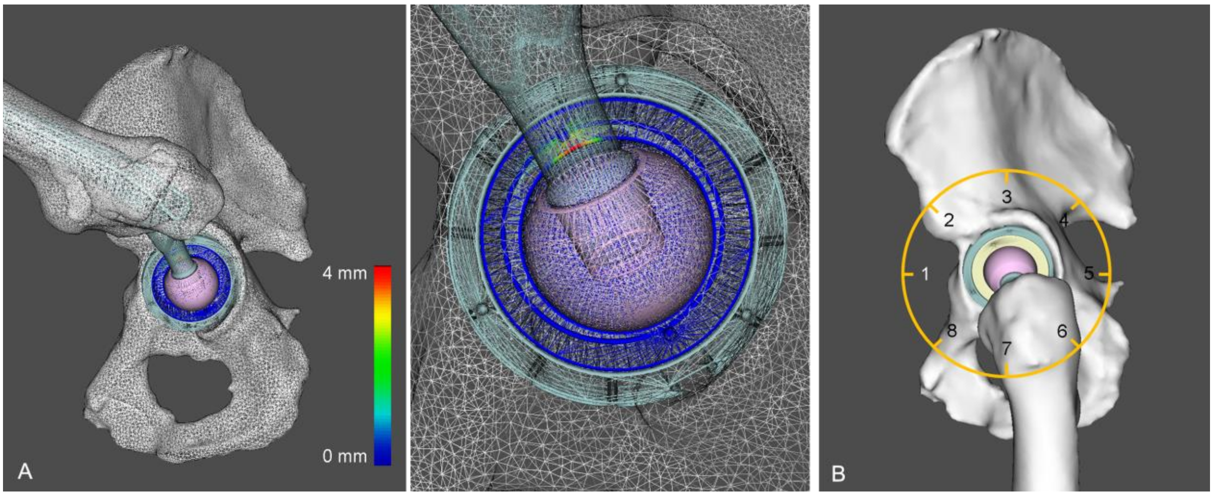

Fig 4. A) Visualization of the impingement region during simulation. The colors represent the distribution of the surface-to-surface distance between two colliding models (here the stem and liner): the blue color is assigned when no collisions are detected (surface-to-surface distance <= 0), while other colors show the impingement zone. The red color denotes the area with the highest contact (surface-to-surface distance = max). B) Acetabulum divided into 8 sectors (position 1, anterior; position 2, anterosuperior; position 3, superior; position 4, posterosuperior; position 5, posterior; position 6, posteroinferior; position 7, inferior; position 8, anteroinferior) to report the location of the impingement zone.

Statistical Analysis

A statistical analysis was conducted for each of the 12 common sexual positions for men and women. Hip ROM from the trials recorded during motion capture were determined for all subject's hips and for all positions. We computed the mean values and standard deviations (SD) of range of motion according to the three standard anatomical angles.

We calculated the frequency of prosthetic and bony impingement and the distribution of the zone of impingement. We also computed the hip ROM and the amount and direction of subluxation when impingement occurred.

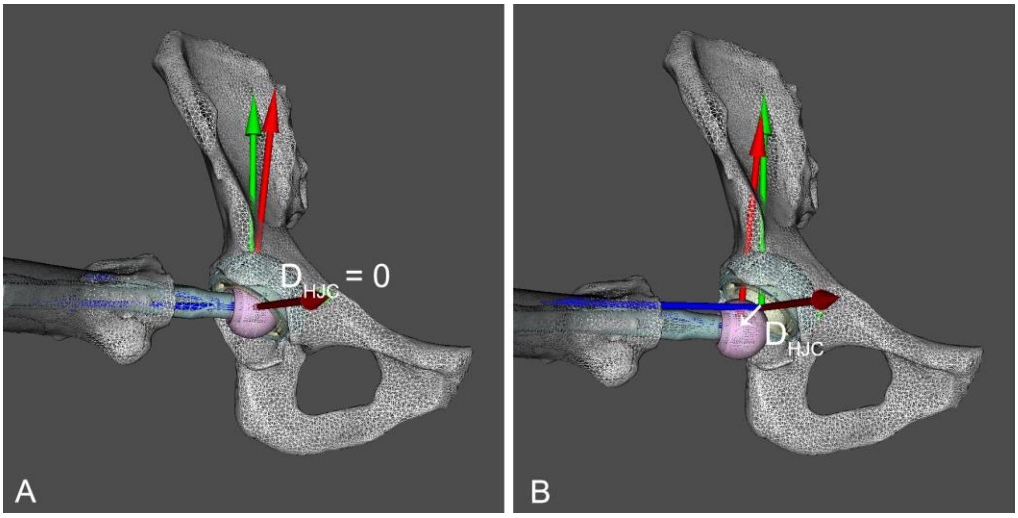

Fig 5. The vector $\mathbf{D_{HJC}}$ used to quantify joint instability: A) the vector is null and the two coordinate systems have same origin, no subluxation is noted, B) the vector denotes a subluxation.

Results

According to the morphological analysis, the hips of the two volunteers did not present any morphological anomaly. Abnormal joint behaviors should therefore not have affected the kinematic data recorded from motion capture.

As shown in Table 1, sexual positions for women required flexion, abduction and mostly external rotation. Positions #3, #5, #6 and #10 were the more demanding in terms of flexion (> 95°) and positions #4, #7, #10 and #12 in terms of abduction (> 32°). For men, flexion and abduction remained in the normal range, but external rotation was dominant for all positions (Table 2). Moreover, external rotation superior or equal to 40° was achieved for positions #5, #6, #8 and #11.

Prosthetic impingements occurred during one or more of the sexual positions for women at 6 cup positions (Table 3). No bone-to-bone impingements were detected. Three cup positions (45-30, 60-15, 60-30) did not incur an impingement for any of the motion challenges considered. However, these combinations are often subject to greater stress concentrations and wear [10, 27]. Regardless the cup positions, most impingements were observed in positions #3 (33%), #5 (38%), and #10 (16%) which were the positions requiring the highest hip flexion. One impingement at cup position 40-0 was also noted for position #8. Concerning the location of impingements, they were located in either the anterosuperior or anterosuperior/superior area of the acetabulum (position 2 and 2/3 according to our documentation). Subluxation was posterior for all sexual positions and varied between 1.14 and 5.12 mm.

Impingements between the lesser trochanter and ischium occurred during one sexual position for men (positions #8) at all cup positions (Table 4). This could be explained by the high degree of external rotation combined with extension and adduction. In position #8, prosthetic impingements were also observed for the cups with 30° anteversion and for the cup position 60-15. In addition, one impingement was noted for position #11 at cup position 60-30. The contacts were located in the posteroinferior quadrant of the acetabulum, which makes those cup positions more favorable to abutment in such area. Subluxation was anterior for the two sexual positions where impingements were detected and varied between 0.51 and 4.99 mm.

Discussion

Patients wonder about the risk related to sexual activity after THA. As previously mentioned in the introduction, this aspect remains largely unexplored if we refer to the literature in this domain. The surgeon or other healthcare professionals thus lack scientifically validated information on appropriate answers or guidelines and are therefore unable to provide specific instructions to patient's inquiries. Moreover, little is known about the range of motion of the hip joint necessary to execute sexual positions. In this paper, we have presented an in-vivo study based on motion capture to accurately determine the active ROM of the hip joint during 12 common sexual positions. With the use of captured motion, computer simulations of prosthetic hip joint 3D models were performed to objectively evaluate impingement and related joint instability during motion. As far as we know, this is the first in-vivo study of the hip joint during sexual positions.

The frequency of impingement and dislocation depends very much on the surgical orientation of the implanted components, especially the acetabular cup [28, 29]. In this study, prosthetic impingements occurred during one or more of the sexual positions for women at 6 cup positions. Three cup positions (45-30, 60-15, 60-30) did not encounter impingement for any of the motion challenges considered, but they were out of the conventional "safe zone" of acetabular cup orientations. These findings are not intended to be directly predictive of clinical experience, but rather indicate that 4 sexual positions for women could be potentially at risk even with well oriented cups.

For men, only one sexual position encountered bony impingements in all cup positions. When impingement was detected, the hip was in external rotation combined with extension and adduction. This type of impingement between the lesser trochanter and ischium is typical in this range of motion [30]. One explanation for this hip position, in particular the high degree of external rotation, could be the fact that the volunteer of this study was resting on his feet externally rotated in order to contract the buttocks and permit forward movement of the pelvis. However, as we did not capture many volunteers, we cannot verify if similar patterns of movements are observed in other individuals.

Dislocation is a frequent cause of implant failure that occurs because of impingement [8, 28, 31]. In Dahm et al. [7], 20% of the surgeons surveyed reported knowledge of at least one patient experiencing THA dislocation during sexual relations. In this study, the computed impingements in sexual positions for women were located in the anterosuperior area of the acetabulum leading to posterior subluxation. In men positions, they were located in the posteroinferior acetabular area leading to anterior subluxation. These instability patterns were consistent with previous works [9, 10]. However, dislocation cannot be precisely evaluated without a more advanced simulation taking into accounts the loads and mechanical behavior of the prosthesis. Nevertheless, according to our data, there is little doubt that bony or prosthetic impingement could compromise the stability of the prothesis during sexual activity.

For Dahm et al. [7], 5 sexual positions for men and 3 positions for women of the 12 evaluated were considered acceptable after THA. These positions were those in which the patient minimized the hip ROM, notably the risk of dislocation. In Lafosse et al. [2], we can notice that female patients implicitly follow these recommendations where positions requiring little mobility were chosen after THA. Men, however, used the same positions before and after THA. Our study confirmed these findings, but also provided precise information on the risk positions. Indeed, impingements occurred in sexual positions for women requiring the highest hip flexion combined with abduction. Sexual positions for men required less mobility and could be therefore considered as safer. Unlike Dahm et al. [7], the results of our simulation seems to indicate that only 4 positions for women and 1 position for men should be avoided after THA (Fig. 6).

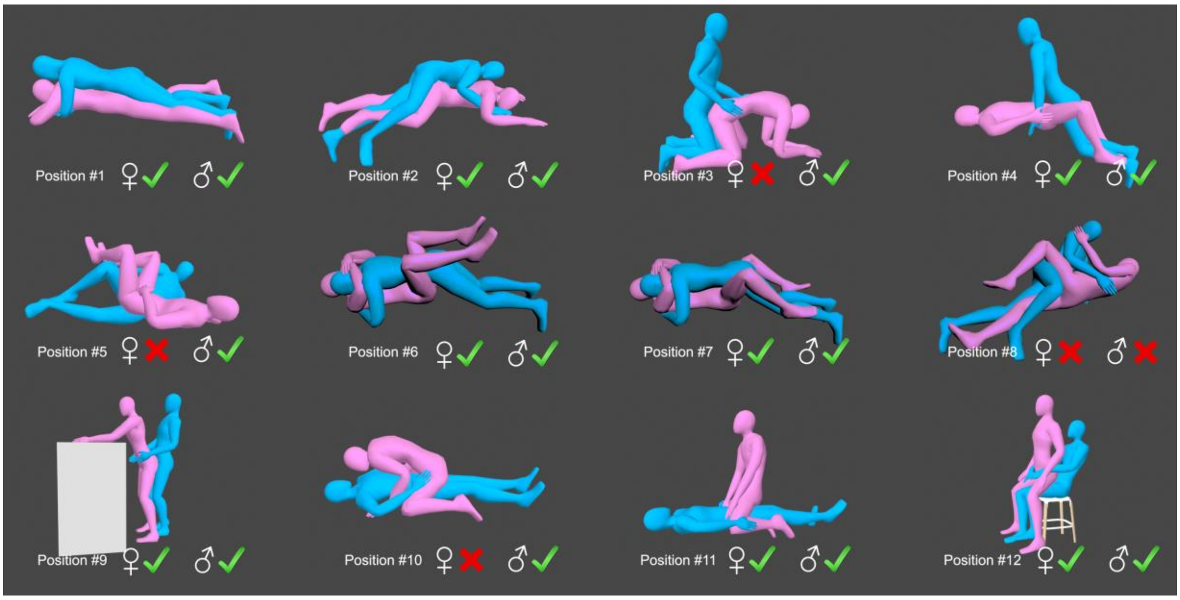

Fig 6. Sexual positions for men and women recommended after THA. In all images, the man is represented in blue and the woman in pink. A cross next to each symbol means that the position should be avoided; a tick means that the position is allowed.

We acknowledge limitations to our study: 1) the small number of participants (1 female and 1 male) which could be explained by the sensitive nature of the experiment to which the subjects are asked to participate; 2) the accuracy of the global set-up subject to two sources of errors, the 3D bone reconstruction from MRI data (error ≈ 1.25 mm) and the kinematics computation from motion capture data (translational error ≈ 0.5 mm, rotational error < 3°); 3) the nature of the simulation which does not take into account the contributions of loads and soft tissue structures around the joint that are expected to play an important role in the impingement or dislocation process. Despite these potential limitations, we do believe in the validity of the conclusions of this preliminary study.

In summary, sexual positions for women require extreme hip ROM (high flexion combined with abduction and mostly external rotation), whereas sexual positions for men require less mobility (but with pronounced external rotation). This study objectively demonstrated that bony or prosthetic impingement associated with joint instability occurred during sexual activity after THA. Some sexual positions could be hence potentially at risk after THA, particularly for women. We believe that this study provides valuable data to be used by clinicians when advising patients as to sexual positions that may be practiced after THA.

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Tables

Table 1 Hip ROM (°) during sexual positions for women. Results for symmetric positions are reported for both legs together.

Movements		Mean	SD
Position #1			
	Flex	5	3.5
	Abd	16	0.7
	IR/ER	0/18	4.2
Position #2 (lying on the left side), right leg			
	Flex	74	2.1
	Abd	14	1.6
	IR/ER	0/16	3.9
Position #2 (lying on the left side), left leg			
	Flex	13	0.5
	Abd	1	4.1
	IR/ER	0/13	2.8
Position #3			
	Flex	96	3.5
	Abd	27	2.1
	IR/ER	0/2	0.7
Position #4			
	Flex	22	2.8
	Abd	35	6.4
	IR/ER	0/20	1.4
Position #5			
	Flex	108	5.7
	Abd	6	17.7
	IR/ER	0/9	2.1
Position #6			
	Flex	100	3.5
	Abd	26	0.7
	IR/ER	0/7	1.4
Position #7			
	Flex	56	3.5
	Abd	34	2.8
	IR/ER	0/4	6.4
Position #8 (lying on the right side), right leg			
	Flex	4	1.1
	Abd	10	5.3
	IR/ER	9/0	4.2
Position #8 (lying on the right side), left leg			
	Flex	82	2.4
	Abd	29	2.5
	IR/ER	5/0	4.1
Position #9			
	Flex	45	4.2
	Abd	7	2.8
	IR/ER	0/9	1.4
Position #10			
	Flex	95	6.4
	Abd	35	2.1
	IR/ER	4/0	4.2

Position #11			
	Flex	49	2.1
	Abd	26	1.4
	IR/ER	17/0	9.9
Position #12			
	Flex	70	4.2
	Abd	32	1.4
	IR/ER	0/15	2.1

Table 2 Hip ROM (°) during sexual positions for men. Results for symmetric positions are reported for both legs together.

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

Position #11			
	Flex/Ext	3/0	0.7
	Abd/Add	1/0	9.9
	ER	42	17.0
Position #12			
	Flex/Ext	44/0	5.7
	Abd/Add	2/0	4.9
	ER	11	14.1

Table 3 Impingement's location, subluxation (mm) and hip ROM (°) when impingement occurred during sexual positions for women. Only the positions where impingements occurred are reported.

	Side	0° anteversion					15° anteversion					30° anteversion				
		Location*	Subluxation	Flex	Abd	IR/ER	Location*	Subluxation	Flex	Abd	IR/ER	Location*	Subluxation	Flex	Abd	IR/ER
Position #3																
40° inclination	R	2/3	2.51	91	27	5/0	-	-	-	-	-	2/3	1.14	91	27	5/0
	L	2/3	2.83	98	24	6/0	2/3	1.93	98	24	6/0	2/3	2.79	98	24	6/0
45° inclination	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L	2/3	1.86	98	24	6/0	-	-	-	-	-	-	-	-	-	-
60° inclination	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Position #5																
40° inclination	R	2	2.55	85	7	0/7	-	-	-	-	-	-	-	-	-	-
	L	2	5.12	98	10	0/9	2	3.93	98	13	0/2	2	2.34	99	13	0/3
45° inclination	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L	2	3.34	96	7	0/6	2	1.47	98	10	0/9	-	-	-	-	-
60° inclination	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L	2	3.27	98	13	0/3	-	-	-	-	-	-	-	-	-	-
Position #8																
40° inclination	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L	2	2.78	82	13	7/0	-	-	-	-	-	-	-	-	-	-
45° inclination	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
60° inclination	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Position #10																
40° inclination	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L	2/3	2.67	97	33	7/0	2/3	2.35	97	33	7/0	2/3	2.66	97	33	7/0
45° inclination	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

60° inclination	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

* Location of the impingement zone around the acetabulum according to our documentation (2 = anterosuperior, 2/3 = anterosuperior/superior)

Table 4 Impingement's location, subluxation (mm) and hip ROM (°) when impingement occurred during sexual positions for men. Only the positions where impingements occurred are reported.

	Side	0° anteversion					15° anteversion					30° anteversion				
		Location*	Subluxation	Ext	Add	ER	Location*	Subluxation	Ext	Add	ER	Location*	Subluxation	Ext	Add	ER
Position #8																
40° inclination	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L	6**	2.35	2	19	42	6**	2.35	2	19	42	6†	2.09	4	12	47
45° inclination	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L	6**	2.35	2	19	42	6**	2.35	2	19	42	6†	2.62	4	12	47
60° inclination	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L	6**	2.35	2	19	42	6†	3.41	4	12	47	6†	4.99	4	12	47
Position #11																
40° inclination	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45° inclination	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
60° inclination	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	L	-	-	-	-	-	-	-	-	-	-	6	0.51	0	6	48

* Location of the impingement zone around the acetabulum according to our documentation (6 = posteroinferior)
** Bony impingements occurred
† Both prosthetic and bony impingements occurred