

Does Pelvic Sagittal Inclination in the Supine and Standing Positions Change Over 10 Years of Follow-Up After Total Hip Arthroplasty?



Tutor
Professor Jin Qunhua

Student
Tian Xiaoping

2018-11-28

CONTENT

01

Abstract

02

Introduction

03

Methods

04

Results

05

Discussion



Abstract

Background: Functional anteversion and inclination of the cup change as the pelvic sagittal inclination (PSI) changes. The purposes of this study were to investigate the chronological changes of PSI during a 10-year follow-up period after total hip arthroplasty (THA) and to report the characteristics of patients who showed a greater than 10° change in the PSI from the supine to the standing position.

Methods: The subjects were 70 patients who were followed up for 10 years after THA. PSI values in the supine and standing positions were measured by 2D-3D matching using computed tomography images and pelvic radiographs. PSI values before THA and 1, 5, and 10 years after THA were compared in both the supine and standing positions.



Results: Supine PSI showed less than 5° of change, whereas standing PSI showed a significant decrease with time over the 10-year period. Although 43% of patients with less than 10° of difference in the PSI between the supine and standing positions before THA increased PSI posteriorly (reclining) more than 10° in standing from the supine position at 10 years, no late dislocation was observed.

Conclusion: Supine PSI showed no significant change, but standing PSI showed a significant increase posteriorly with time over a 10-year period. However, this PSI change did not reach the level that it caused negative consequences such as late dislocation. The pelvic position in the supine position might still be a good functional reference position of the pelvis for aiming to achieve proper cup alignment at 10 years.



Introduction

Previous studies suggested that the mean change in pelvic sagittal inclination (PSI) in both the supine and standing positions between before total hip arthroplasty (THA) and after THA was within about 5° early after THA.

However, there have been no longterm follow-up studies about the change in PSI after THA.

If the PSI in each position long after THA is different from that before THA, it can be a cause of sequelae due to functional malalignment of the cup.

Because patients are getting older after THA, their risk of having some spinal diseases such as degenerative disc diseases, degenerative spondylolisthesis, and osteoporotic compression fractures is increasing.



These spinal disorders and aging itself are related to PSI change, particularly in the standing position.

If the PSI in the supine position and in the standing position changes after THA, there is a concern that, even if the cup is placed in the target zone in the pelvis in the supine position, the risk of posterior impingement and anterior dislocation may increase after THA for such atypical patients.

To improve the outcome of THA, it is important to appreciate the chronological changes of PSI long after THA.



Methods

This was a retrospective review study of 101 consecutive patients who underwent THA , and the imaging data acquisition was performed in a prospective fashion. These patients were informed about the study that required anteroposterior (AP) radiographs of the pelvis in both the supine and standing positions at 1, 5, and 10 years after THA. Seventy patients completed 10-year follow-up, There were 56 women and 14 men.

Computed tomography (CT) of the pelvis was also performed preoperatively for CT-based navigation THA. By matching CT imaging with pelvic radiographs, PSI at each time point (before THA and 1, 5, and 10 years after THA) in both the supine and standing positions was measured.



- 1. By using 3D viewer software , the multiplanar reconstruction (MPR) image of the pelvis was made from CT images.**
- 2. The ratio of the vertical diameter to the horizontal diameter (VH ratio) of the pelvic foramen on the pelvic radiograph was measured.**
- 3. To match the VH ratio on a DRR to that on a radiograph, the pelvis was sagittally rotated on the MPR.**

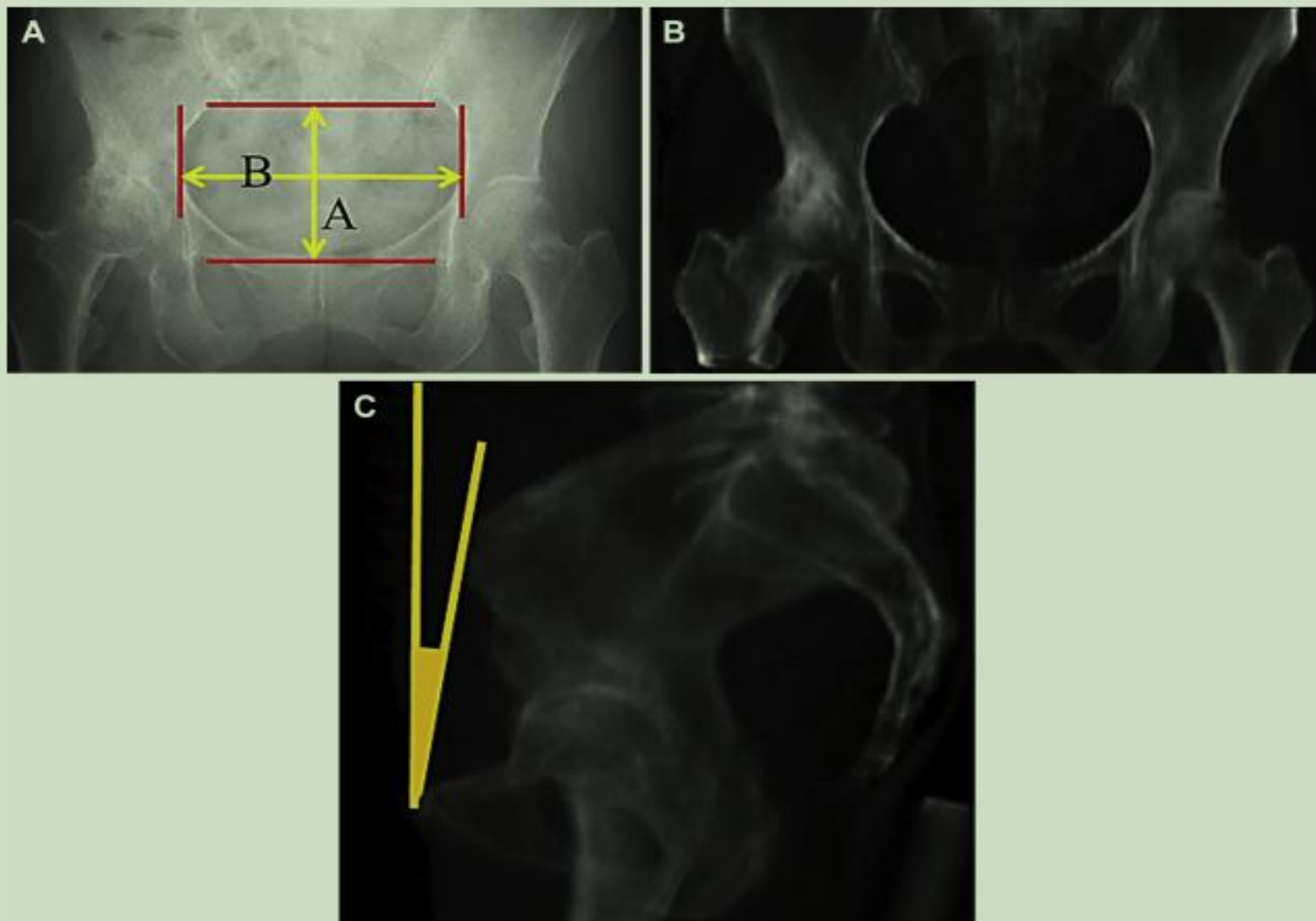


Fig. 1. Measurement of pelvic sagittal inclination (PSI) in the standing position. (A) On anteroposterior (AP) radiographs of the pelvis in a standing position, the vertical diameter of the pelvic foramen (A) divided by the horizontal diameter of the pelvic foramen (B) is calculated as the ratio of the vertical diameter to the horizontal diameter (VH ratio). (B) The pelvis is rotated sagittally until the VH ratio of the pelvic foramen on digitally reconstructed radiograph (DRR) becomes similar to that on standing AP radiographs. (C) On sagittal DRR, the angle between the anterior pelvic plane and the vertical axis is measured as PSI in the standing position.



Patterns of PSI changes from the supine position to the standing position were investigated in each time period. **Pattern P** was defined as the patients whose pelvises tilted posteriorly more than 10° from the supine position to the standing position. **Pattern A** was defined as the patients whose pelvises tilted anteriorly more than 10° from the supine position to the standing position at THA. **Pattern N** was defined as the remaining patients.



Results

PSI in the standing position was significantly smaller than PSI in the supine position at each time point, except before THA (**Table 1**). PSI in the supine position at 1 year after THA tilted significantly posteriorly from the PSI before THA, but the change in PSI in the supine position plateaued after 1 year (**Fig. 2**) The mean change of PSI in the supine position between before THA and 10 years after THA was $2.9^{\circ} \pm 5.6^{\circ}$ (-16.7 to 8.1). PSI in the standing position continued to decrease until 10 years after THA. The mean change of PSI in the standing position between before and 10 years after THA was $11.4^{\circ} \pm 13.2^{\circ}$ (-45.0 to 15.0).

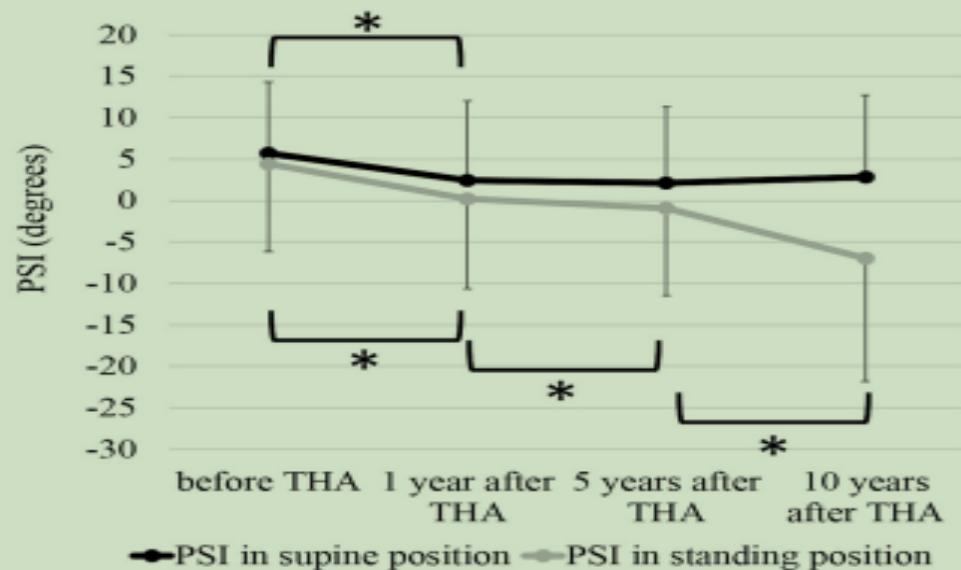


Fig. 2. The changes of PSI in the supine and standing positions over 10 years of follow-up. PSI in the supine position at 1 year after THA is tilted significantly posteriorly from the PSI before THA, but the change in PSI in the supine position plateaus after 1 year. PSI in the standing position continues to decrease over the 10 years after THA (* $P < .05$, Wilcoxon signed rank test). THA, total hip arthroplasty.

Table 1

PSI in the Supine and Standing Positions at Each Time Point in All Patients.

	PSI (Supine)	PSI (Standing)	<i>P</i> Value ^a
Before THA	5.7 ± 8.6 (−15.9 to 29.6)	4.4 ± 10.6 (−12.0 to 33.0)	.09
1 y after THA	2.4 ± 9.6 (−14.0 to 30.0)	0.2 ± 10.8 (−23.0 to 36.0)	<.01
5 y after THA	2.1 ± 9.2 (−18.0 to 30.0)	−0.9 ± 10.5 (−21.0 to 35.0)	<.01
10 y after THA	2.8 ± 9.9 (−20.0 to 30.0)	−7.0 ± 14.8 (−40.0 to 41.0)	<.01

Mean ± standard deviation (range).

PSI, pelvic sagittal inclination; THA, total hip arthroplasty.

^a Wilcoxon signed rank test.



The percentages of patients who showed pattern P at each time point was 6% before THA, 6% at 1 year, 12% at 5 years, and 45% at 10 years (**Fig. 3**). There were no significant differences in age, sex, and preoperative PSI in the supine or standing positions between type P and type C (**Table 2**). In type P, PSI in the supine position at 1 year after THA tilted significantly posteriorly from the PSI before THA, but the change in PSI in the supine position plateaued after 1 year, and PSI in the standing position continued to decrease over the 10 years after THA (**Fig. 4**). In type C, PSI in the supine position was not changed over 10 years of follow-up after THA, and PSI in the standing position continued to decrease until 10 years after THA (**Fig. 5**).

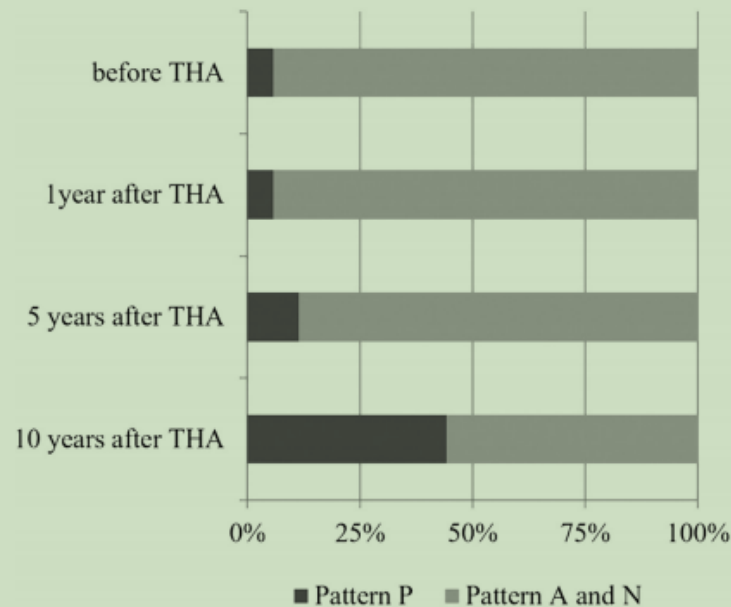


Fig. 3. Percentages of patients who showed Pattern P and Pattern A/N during 10 years of follow-up

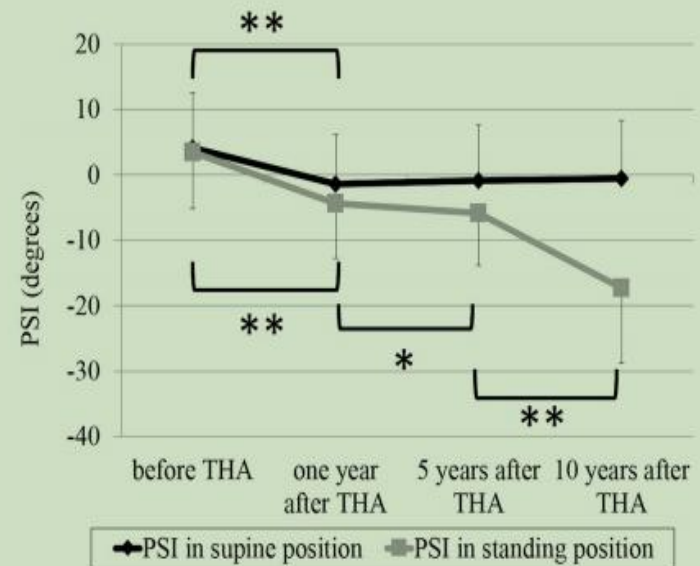


Fig. 4. Changes of PSI in the supine and standing positions over 10 years of follow-up in type P (* $P < .05$, ** $P < .01$).

Table 2
The Characteristics of Type P and Type C Patients.

	Type P (N = 27)	Type C (N = 36)	P Value
Age (y)	57.9 ± 11.3 (23 to 77)	53.7 ± 9.0 (24 to 68)	.09 ^a
Sex (male/female)	3/24	10/26	.12 ^b
PSI (supine)			
Before THA	4.1 ± 8.4 (-15.9 to 20.7)	6.7 ± 9.3 (-9.3 to 29.6)	.37 ^a
1 y after THA	-1.4 ± 7.6 (-14.0 to 15.0)	5.2 ± 10.9 (-13.0 to 30.0)	.02 ^a
5 y after THA	-0.8 ± 8.5 (-18.0 to 15.0)	4.1 ± 10.0 (-15.0 to 36.0)	.07 ^a
10 y after THA	-0.5 ± 8.8 (-20.0 to 16.0)	4.8 ± 11.0 (-15.0 to 30.0)	.08 ^a
PSI (standing)			
Before THA	3.5 ± 8.6 (-12.0 to 25.0)	5.2 ± 10.8 (-10.0 to 33.0)	.71 ^a
1 y after THA	-4.3 ± 8.5 (-23.0 to 16.0)	3.7 ± 11.6 (-15.0 to 36.0)	<.01 ^a
5 y after THA	-5.8 ± 8.0 (-21.0 to 13.0)	2.8 ± 11.0 (-17.0 to 35.0)	<.01 ^a
10 y after THA	-17.3 ± 11.5 (-40.0 to 3.0)	0.6 ± 12.8 (-24.0 to 41.0)	<.01 ^a
Lumbar lordosis angle before THA	48.1 ± 12.2 (27.0 to 74.0)	49.5 ± 10.2 (25.0 to 67.0)	.54 ^a
Change of the lumbar lordosis angle over 10 y	-5.1 ± 12.4 (-30.8 to 22.0)	-0.3 ± 8.9 (-21.0 to 26.2)	.08 ^a
Presence of compression fracture before THA	2	0	.18 ^b
New occurrence of compression fractures	4	1	.16 ^b
Presence of lumbar spondylolisthesis before THA	2	2	.00 ^b
New occurrence of lumbar spondylolisthesis	2	1	.57 ^b

Mean ± standard deviation (range).

PSI, pelvic sagittal inclination; THA, total hip arthroplasty.

^a Mann-Whitney *U* test.

^b Fisher probability test.

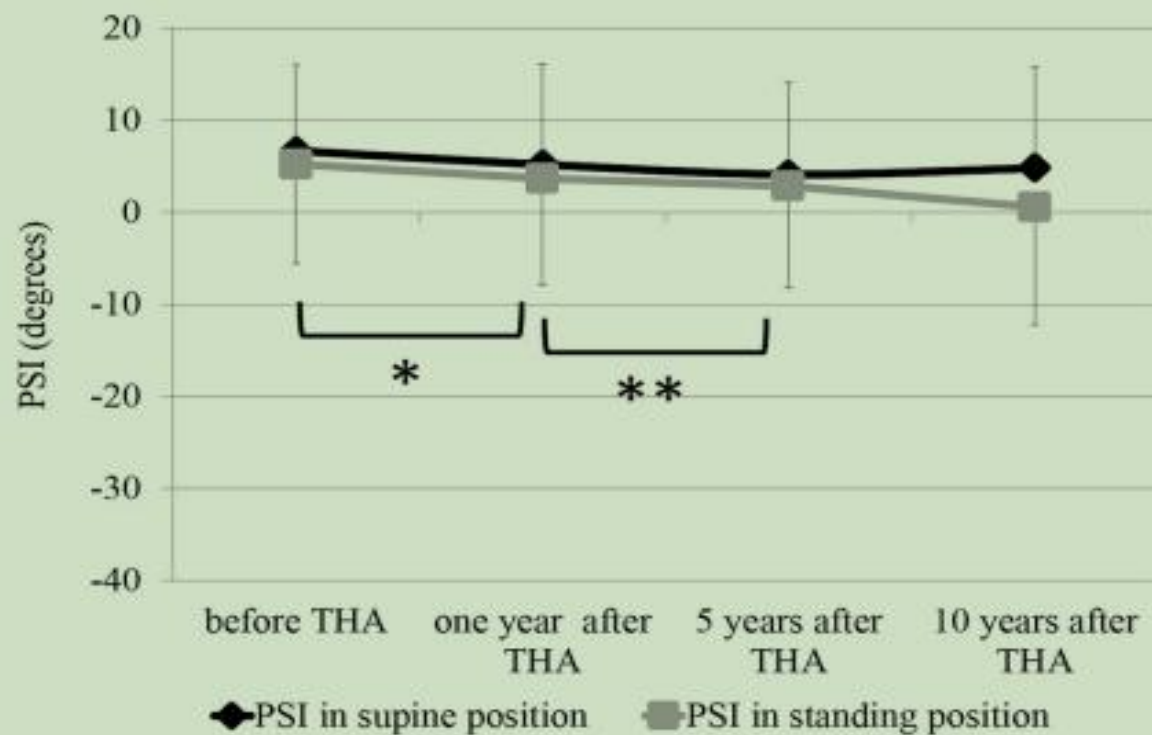


Fig. 5. Changes of PSI in the supine position and in the standing position over 10 years of follow-up in type C (* $P < .05$, ** $P < .01$).



Discussion

Cup malalignment can lead to postoperative complications including dislocation, implant loosening, and breakage or accelerated wear of the bearing parts . Functional cup alignment changes as PSI changes. Some patients show a large change in PSI from the supine position to the standing position, and even if the cup alignment is in a safe zone in the supine position, functional cup alignment in the standing position may go outside of the safe zone, which can lead to impingement and dislocation .



This study suggests that the pelvic position in the supine position is still a good functional reference position of the pelvis for aiming cup alignment. However, a further study with a larger number of subjects and a longer term follow-up may reveal a more serious clinical impact of chronological changes in PSI.



In conclusion, PSI in the supine position showed no significant changes, but PSI in the standing position showed a significant increase backward with time over a 10-year period. However, this PSI change did not reach the level of causing negative consequences such as late dislocation. The pelvic position in the supine position might still be a good functional reference position of the pelvis for aiming to achieve proper cup alignment at 10 years.



Thanks

