Association of global sagittal deformity with functional disability two years after total hip arthroplasty

Yoshinori Okamoto (✉ ort141@osaka-med.ac.jp)  
Osaka Medical College: Osaka Ika Daigaku

Hitoshi Wakama  
Osaka Medical College: Osaka Ika Daigaku

Tomohiro Okayoshi  
Osaka Medical College: Osaka Ika Daigaku

Shuhei Otsuki  
Osaka Medical College: Osaka Ika Daigaku

Masashi Neo  
Osaka Medical College: Osaka Ika Daigaku

Research Article

Keywords: disability, global sagittal deformity, spinopelvic alignment, T1 pelvic angle, total hip arthroplasty

DOI: https://doi.org/10.21203/rs.3.rs-304943/v1

License: ☒ Browsable This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License
Abstract

**Introduction:** The relationship between spinopelvic alignment and functional disability after total hip arthroplasty (THA) has not been fully elucidated despite the growing recognition of its importance on patient-reported outcome measures. We aimed to determine whether global sagittal deformity was associated with post-operative disability.

**Materials and methods:** This prospective analysis was based on 208 THAs that were followed up for 2 years. The Hip Disability and Osteoarthritis Outcome Score-Joint Replacement (HOOS-JR) ranging from a scale of 0 (complete joint disability) to 100 (perfect joint health) was utilised to divide eligible patients into two groups with and without disability, using 70 as the threshold. Multivariate analysis was performed to evaluate the factors associated with disability. To identify the cut-off value of the parameters for predicting disability (HOOS-JR <70/100), we used the receiver-operating characteristic curve.

**Results:** The disability (30 hips) and control (178 hips) groups showed a significant difference in body height (p = 0.020), pre-operative T1 pelvic angle divided by pelvic incidence (T1PA/PI) (p = 0.018), pelvic incidence minus lumbar lordosis (p = 0.027), post-operative HOOS-JR (p = 0.010), and satisfaction (p = 0.033). On multivariate analysis, the following factors were associated with persistent disability: T1PA/PI >0.2 (odds ratio [OR], 2.11; 95% confidence interval [CI], 1.19–4.14; p < 0.001) and height <148 cm (OR, 1.26; 95% CI, 1.09–1.48; p = 0.011). The cut-off value of pre-operative T1PA/PI was >0.19 with a sensitivity of 95% and specificity of 85%. Post-operative satisfaction (p < 0.001) and HOOS-JR (p = 0.023) differed between the two groups when the pre-operative cut-off value was chosen as 0.2.

**Conclusions:** A T1PA/PI >0.2 was associated with greater disability after THA. Clinicians should be aware that patient-related factors, including global spinal deformities, particularly in patients with a short stature, can influence THA outcomes at 2 years postoperatively.

**Introduction**

Despite the proven efficacy of total hip arthroplasty (THA), one in 7–14 patients still report persistent dissatisfaction on short- to medium-term follow-up [1-3]. Some studies have identified the factors affecting patient satisfaction or functional disability, such as pre-operative patient expectations, the degree of improvement, mental health status, comorbidities, and pain relief [1, 2, 4]. Although patient satisfaction plays an important role in assessing therapeutic effects, the impact of the pre-operative spinopelvic alignment on disability after THA has not been reported, even if only over a short term.

Pertinent issues have been raised about the increased incidence of concurrent hip osteoarthritis (OA) and spinal deformities in aging populations [4]. This is seen in approximately 20%–44% of patients undergoing THA [5, 6]. A greater understanding of the association between sagittal spinopelvic alignment and outcomes is also thought to minimise instances of cumbersome dislocation or revision [7, 8]. However, little is known about how sagittal spinal alignment affects THA outcomes, especially that of
patient disability [4, 9-11]. The key to successful THA necessitates a further comprehensive analysis of the influence of sagittal spinopelvic interactions. This argument is important to evaluate, considering the recognition of the importance of patient-reported outcome measures (PROMs) in today's healthcare system.

Furthermore, most large databases, such as the national joint registry or multi-centre studies, are limited to the analysis of PROMs, implant longevity, or complications [12-17]. However, no study has investigated the relationship between spinopelvic alignment and patient disability after THA. A better understanding of patient-related factors is essential to improve the prognosis of THA. Of these factors, resolving the controversy regarding the concurrence of sagittal spinal imbalance and hip OA for clinicians, patients, and policymakers would be particularly important, considering the general super-ageing of our society. The present study aimed to determine whether global sagittal deformity is associated with post-operative disability.

**Materials And Methods**

**Participants**

The study was approved by the institutional review board of our hospital (approval number 1912) and performed in line with the principles of the Declaration of Helsinki (1964) and its subsequent amendments. All patients provided written informed consent for their participation in the study and the publication of their data. Between January 2015 and December 2018, 285 primary THAs were performed at our institution. Of these, 246 Asian patients (270 hips) completed a minimum follow-up of 2 years and were enrolled into this study. From this group, we excluded 34 patients (58 hips) with a staged bilateral THA history (46 hips), history of spinal surgery (five hips), new vertebral compression fracture (three hips) [18], THA with subsequent lumbar spine fusion (two hips), or simultaneous THA (two hips) during the follow-up period. For a few patients, the femoral head was not visible on radiographs and the pelvic incidence (PI) could not be evaluated (four hips) [19]. Ultimately, 208 patients (208 hips) were included in our prospective study (Fig. 1).

**Surgical procedure and post-operative protocol**

All THAs were performed using a direct lateral approach by six experienced arthroplasty surgeons with the patient in the lateral decubitus position [20, 21]. Of them, 260 required acetabular structural bone grafting for the dysplastic acetabulum [21]. The highly cross-linked polyethylene flanged socket (K-MAX CLHO flanged cup, Kyocera Medical, Osaka, Japan) and a cobalt-chromium head with a polished stem (SC stem, Kyocera Medical, Osaka, Japan) were fixed using bone cement (CMW Endurance, DePuy, Blackpool, UK). All patients were post-operatively allowed full weight-bearing for the first 3 months, encouraged as needed, with the use of crutches. This was according to a standardised fast-track protocol, which included standardised physical therapy with mobilisation after drain removal.

**Clinical evaluations**
Before and at 2 years after THA, we used the modified Harris Hip Score (HHS) and the Trendelenburg sign as measures of hip function [22, 23]. The incidence of complications was investigated. Data were analysed in a blinded fashion.

**Patient-reported outcome measures**

We evaluated the patient-reported outcomes pre-operatively and at 2 years post-operatively. The Hip disability and Osteoarthritis Outcome Score, Joint Replacement (HOOS-JR) is a short PROM developed to efficiently evaluate end-stage hip OA in patients undergoing THA. The HOOS-JR is a six-question survey derived from the original 40-question HOOS. Each item on the HOOS-JR is scored from 0 to 28 and then converted into an interval score from 0 (total joint related disability) to 100 (perfect joint health) [23, 24]. A 100-mm visual analogue scale (VAS) was used to evaluate hip pain and patient satisfaction. The 100-mm VAS-pain and satisfaction score was categorised for analysis from a range of “0” mm (no pain and very satisfied) to “100” mm (worst pain imaginable and completely dissatisfied) [15, 23]. The EuroQol 5-Dimension 5-Level (EQ-5D) scale was used as a measure of patient-reported quality of life [23, 25].

**Radiological evaluations**

Spinopelvic alignment was assessed before and at 2 years after THA with the patients in the standing position [26]. Radiographs obtained within 1 month pre-operatively were reviewed for vertebral fractures by an independent arthroplasty surgeon with 10 years of experience. Vertebral fractures were identified using a semiquantitative method, by a decrease in the height of the vertebral body >20% [18]. Radiological measures of the sagittal spinopelvic alignment were obtained using a protractor with 1° increments as follows: C7 sagittal vertical axis (SVA), lumbar lordosis (LL), PI, and T1 pelvic angle (T1PA) [4, 6, 19, 22, 27] (Fig. 2). The T1PA, accounted for global malalignment and/or compensation through pelvic retroversion, was defined as the angle between the line from the femoral head axis to the center of the T1 vertebral body and the line from the femoral head to the centre of the S1 superior end plate. T1PA divided by PI (T1PA/PI) >0.2 as an indicator of an angular measure of global sagittal spinal deformity was associated with lower health-related quality of life in patients undergoing treatment for adult spinal deformity [6]. Osseous complications at the reattached fragment were evaluated on anterior-posterior radiographs obtained at 2 years after THA [20, 21].

To calculate the reliability of the spinopelvic alignment, three experienced arthroplasty surgeons independently evaluated the radiographic parameters, with each observer completing three randomly selected measurements at a mean interval of 4.1 (range, 3.6 to 4.4) weeks for 15 patients each. All observers had specialized in orthopedic surgery and had >6 years of experience. Additionally, they had at least completed a 1-year fellowship in hip surgery under a mentor. Intra- and inter-rater reliability was calculated with a tolerance error of <2° [28].

**Statistical analysis**
Statistical analyses were performed using JMP 14 software (SAS Institute Inc, Cary, NC, USA), and p-values <0.05 were considered statistically significant. We defined a HOOS-JR of 70 as a clinically significant cut-off value and divided eligible subjects into the following two groups for comparison: the disability group, who had a post-operative HOOS-JR <70, indicating hip disability; and the control group, who had a HOOS-JR ≥70, indicating no disability [29].

Differences in the measured variables between the two groups were evaluated using the Mann-Whitney U test for continuous variables. Categorical variables were compared using Fisher’s exact or chi-squared tests as per the data distribution. To identify independent risk factors for the residual disability group, logistic regression analyses were performed. Factors, such as age, sex, body height, body mass index, spinopelvic parameters, and surgeon experience, were analysed using an exploratory univariate analysis followed by a multivariate analysis [1, 4, 7, 13, 15-17, 21]. Surgeons were trichotomised into the following groups: orthopaedic specialists <8 years’, 8-15 years’, and ≥15 years’ experience after certification [15].

A multicollinearity test was performed with the inflation factor set at <10. Age was included as a confounding factor. To identify the cut-off value of the parameters for predicting disability, we used the receiver-operating characteristic (ROC) curve.

Results

The disability (30 hips, 14.4%) and control (178 hips, 85.6%) groups showed a significant difference in body height (p = 0.020), pre-operative T1PA/PI (p = 0.018), PI minus LL (p = 0.027), post-operative HOOS-JR (p = 0.010), satisfaction (p = 0.033), and modified HHS (p = 0.038) (Table 1). However, no significant differences were found between the two groups in terms of complications. Deep infections (one hip, 0.6%), periprosthetic femoral fractures (two hips, 1.1%), and post-operative dislocation (one hip, 0.6%) were observed in the control group, whereas dislocation, fracture, infections, and permanent sciatic nerve palsy (one hip for each, 3.3%) occurred in the disability group.

On regression analysis, patient age at the time of surgery was associated with neither pre-operative nor post-operative measures. The independent variables associated with greater disability were T1PA/PI >0.2 (versus a T1PA/PI ≤0.2; odds ratio, 2.11; p < 0.001) and body height <148 cm (versus a height ≥148 cm; odds ratio, 1.26; p = 0.011) (Table 2).

The diagnostic performance of pre-operative T1PA/PI values was assessed using the ROC curve. The cut-off value of >0.19 had sensitivity of 95% and specificity of 85% (Fig. 3). Even though there was no statistical difference between the two groups pre-operatively, the post-operative measures, such as VAS-satisfaction (p < 0.001) and HOOS-JR (p = 0.023), differed when the pre-operative T1PA/PI cut-off value was chosen as 0.2 (Table 3).

The reliability in measurement was good (intra-class correlation coefficient [ICC], 0.5-0.75) to excellent (ICC >0.75). The inter-observer agreement was higher for T1PA than for PI, SVA, and LL measurement.
(Table 4). The intra- and inter-rater agreements, with a discrepancy of <2°, were as follows: LL, 78.2 % and 84.5 %; PI, 81.3% and 77.5%; and T1PA, 86.5% and 87.1%, respectively.

Discussion

The most important finding of our study was that the pre-existence of global sagittal deformity was associated with patient disability after THA at the 2-year follow-up (p = 0.010) (Table 1). Clinicians should be aware that a spinal sagittal deformity might lead to poor patient-reported outcomes after THA, particularly among patients with a T1PA/PI >0.2 and/or a short stature (Table 2).

Previous studies that have evaluated sagittal spinopelvic parameters on THA outcomes have employed dislocation and revision as the study end-points [4, 9, 11]. Other studies have focused on evaluating measures of alignment obtained in sitting and standing postures as dynamic risk factors for dislocation [8, 10]. Only a few studies have retrospectively evaluated the effect of pre-operative sagittal spinopelvic alignment on outcomes after THA [22, 29]. Ochi et al. found that THA patients with pre-operatively imbalanced sagittal alignment had poorer outcomes according to the modified HHS, and pre-operative spinopelvic alignment predicted post-operative hip function ranging from 3 to 26 months [22]. Perrone et al. proposed that patients with a high PI had a significantly better HOOS after THA than those with a low PI (56.4° versus 48.7°, p = 0.006) [29]. These studies did not evaluate the relationship between global sagittal deformity and functional disability after THA.

In our study, we used T1PA/PI measures to evaluate the effects of global sagittal deformity on patient disability after THA. The T1PA combines information from both the SVA and pelvic tilt simultaneously to measure the geometry of global spinal deformity more directly [6]. Our results showed that a pre-operative T1PA/PI >0.2 was associated with lower satisfaction after THA (p < 0.001) (Tables 3). Moreover, body height <148 cm (p = 0.011) was an independent risk factor for persistent disability (Table 2). A short stature, defined by a body height of <148 cm, can lead to an atypical load distribution on the spine and a delay in the process of ossification [13]. The proportion of patients with a short stature in our study group was higher than the 0.8% rate reported by Anis et al. [13] (Table 1). We did identify that patients with a T1PA/PI >0.2 were shorter than the others (p = 0.021) (Table 3).

This study had several limitations. The main limitation was a relatively small study sample, which limited the statistical power of our results. Second, we investigated only cemented implants using a direct lateral approach [20, 21]. It may be difficult to apply our results to other populations. We do note that, among Asian populations, the primary indication for THA is secondary OA caused by developmental acetabular dysplasia with a greater prevalence in women than in men [21, 22]. In fact, only 12% of our patients were men; therefore, our results cannot be generalised to other implant types, approaches, or ethnicities [4, 12, 30] (Table 1). Third, the analyses cannot be performed for dynamic changes with the patient in the sitting or supine position [7]. Lastly, our follow-up period was relatively short [14, 16]. Additional follow-up information would be required to determine long-term results [14].
Despite these limitations, our study does highlight that several pre-operative factors could affect functional disability 2 years after THA. It could be that their post-operative satisfaction merely reflects general personalities and/or medical expectations, rather than being a proxy for recovery among other things; however, the strength of our study lies in the finding that the pre-operative T1PA/PI was associated with disability after THA. Our findings are clinically relevant and indicate that spinopelvic sagittal alignment should be precisely evaluated before THA to improve patient satisfaction [11]. The management of these individuals could include perioperative interventions, such as the prescription of an orthosis and/or physical therapy, or involve prediction of subsequent spinal surgery. In our findings, the focus on PROMs also provides novel information on possible differences among patients with and without a T1PA/PI >0.2; this could be helpful in setting expectations for patients and surgeons before THA (Table 4). Interestingly, the thresholds obtained from the ROC curve in this study was similar to that reported in a previous study [6] (Fig. 3).

In conclusion, global sagittal deformity, especially in patients with a T1PA/PI >0.2 and/or short patient stature, was associated with a higher disability rate at the 2-year follow-up after THA. Clinicians should be aware of the influence of several pre-operative factors on disability, 2 years after THA. Further studies are warranted to improve our understanding of PROMs, long-term function, and patient satisfaction after THA.

References

1. Anakwe RE, Jenkins PJ, Moran M (2011) Predicting dissatisfaction after total hip arthroplasty: a study of 850 patients. J Arthroplasty 26(2):209-213. https://doi.org/10.1016/j.arth.2010.03.013

2. Berliner JL, Brodke DJ, Chan V, SooHoo NF, Bozic KJ (2016) John Charnley Award: Preoperative patient-reported outcome measures predict clinically meaningful improvement in function after THA. Clin Orthop Relat Res 474(2):321-329. https://doi.org/10.1007/s11999-015-4350-6

3. Yeo MGH, Goh GS, Chen JY, Lo NN, Yeo SJ, Liow MHL (2020) Are Oxford Hip Score and Western Ontario and McMaster Universities Osteoarthritis Index Useful Predictors of Clinical Meaningful Improvement and Satisfaction After Total Hip Arthroplasty? J Arthroplasty 35(9):2458-2464. https://doi.org/10.1016/j.arth.2020.04.034

4. Buckland AJ, Ayres EW, Shimmin AJ, Bare JV, McMahon SJ, Vigdorchik JM (2020) Prevalence of sagittal spinal deformity among patients undergoing total hip arthroplasty. J Arthroplasty 35(1):160-165. https://doi.org/10.1016/j.arth.2019.08.020

5. Prather H, Van Dillen LR, Kymes SM, Armbricht MA, Stwalley D, Clohisy JC (2012) Impact of coexistent lumbar spine disorders on clinical outcomes and physician charges associated with total hip arthroplasty. Spine J 12(5):363-369. https://doi.org/10.1016/j.spinee.2011.11.002

6. Durand WM, Daniels AH, Hamilton DK, Passias P, Kim HJ, Protopsaltis T, LaFage V, Smith JS, Shaffrey C, Gupta M, Kelly MP, Klineberg E, Schwab F, Burton D, Bess S, Ames C, Hart R, International Spine Study Group (ISSG) (2020) The spino-pelvic ratio: a novel global sagittal parameter associated
with clinical outcomes in adult spinal deformity patients. Eur Spine J 29(9):2354-2361. https://doi.org/10.1007/s00586-020-06472-x

7. Buckland AJ, Fernandez L, Shimmin AJ, Bare JV, McMahon SJ, Vigdorchik JM (2019) Effects of sagittal spinal alignment on postural pelvic mobility in total hip arthroplasty candidates. J Arthroplasty 34(11):2663-2668. https://doi.org/10.1016/j.arth.2019.06.036

8. DelSole EM, Vigdorchik JM, Schwarzkopf R, Errico TJ, Buckland, AJ (2017) Total hip arthroplasty in the spinal deformity population: does degree of sagittal deformity affect rates of safe zone placement, instability, or revision? J Arthroplasty 32(6):1910-1917. https://doi.org/10.1016/j.arth.2016.12.039

9. Buckland AJ, Vigdorchik J, Schwab FJ, Errico TJ, Lafage R, Ames C, Bess S, Smith J, Mundis GM, Lafage V (2015) Acetabular anteversion changes due to spinal deformity correction: bridging the gap between hip and spine surgeons. J Bone Joint Surg Am 97(23):1913-1920. https://doi.org/10.2106/jbjs.o.00276

10. Grammatopoulos G, Gofton W, Jibri Z, Coyle M, Dobransky J, Kreviazuk C, Kim PR, Beaulé PE (2019) 2018 Frank Stinchfield Award: Spinopelvic hypermobility is associated with an inferior outcome after THA: examining the effect of spinal arthrodesis. Clin Orthop Relat Res 477(2):310-321. https://doi.org/10.1097/corr.0000000000000367

11. Sultan AA, Khlopas A, Piuzzi NS, Chughtai M, Sodhi N, Mont MA (2018) The impact of spino-pelvic alignment on total hip arthroplasty outcomes: a critical analysis of current evidence. J Arthroplasty 33(5):1606-1616. https://doi.org/10.1016/j.arth.2017.11.021

12. Amlie E, Havelin LI, Furnes O, Baste V, Nordsletten L, Hovik O, Dimmen S (2014) Worse patient-reported outcome after lateral approach than after anterior and posterolateral approach in primary hip arthroplasty. A cross-sectional questionnaire study of 1,476 patients 1-3 years after surgery. Acta Orthop 85(5):463-469. https://doi.org/10.3109/17453674.2014.934183

13. Anis HK, McConaghy KM, Charles RJ, Warren JA, Santana DC, Klika AK, Barsoum WK, Krebs VE, Higuera CA, Piuzzi NS (2020) Perioperative outcomes and complications after primary total hip arthroplasty in patients with disproportionately short stature: a matched cohort analysis. J Arthroplasty 35(3):801-804. https://doi.org/10.1016/j.arth.2019.10.019

14. Galea VP, Rojanasopondist P, Ingelsrud LH, Rubash HE, Bragdon C, Huddleston Iii JI, Malchau H, Troelsen A (2019). Longitudinal changes in patient-reported outcome measures following total hip arthroplasty and predictors of deterioration during follow-up: a seven-year prospective international multicentre study. Bone Joint J 101-B(7):768-778. https://doi.org/10.1302/0301-620x.101b7.bjj-2018-1491.r1

15. Jolbäck P, Rolfson O, Mohaddes M, Nemes S, Kärrholm J, Garellick G, Lindahl H (2018) Does surgeon experience affect patient-reported outcomes 1 year after primary total hip arthroplasty? Acta Orthop 89(3):265-271. https://doi.org/10.1080/17453674.2018.1444300

16. Lalani A, Lee YY, Pitta M, Westrich GH, Lyman S (2019) Age-related decline in patient-reported outcomes 2 and 5 years following total hip arthroplasty. J Arthroplasty 34(9):1999-2005.
17. Rolfson O, Kärrholm J, Dahlberg LE, Garellick G (2011) Patient-reported outcomes in the Swedish Hip Arthroplasty Register: results of a nationwide prospective observational study. J Bone Joint Surg Br 93(7):867-875. https://doi.org/10.1302/0301-620x.93b7.25737

18. Genant HK, Wu CY, van Kuijk C, Nevitt MC (1993) Vertebral fracture assessment using a semiquantitative technique. J Bone Miner Res 8(9):1137-1148. https://doi.org/10.1002/jbmr.5650080915

19. Legaye J, Duval-Beaupere G, Hecquet J, Marty C (1998) Pelvic incidence: a fundamental pelvic parameter for three-dimensional regulation of spinal sagittal curves. Eur Spine J 7(2):99-103. https://doi.org/10.1007/s005860050038

20. Dall D (1986) Exposure of the hip by anterior osteotomy of the greater trochanter. A modified anterolateral approach. J Bone Joint Surg Br 68(3):382-386. https://doi.org/10.1302/0301-620x.68b3.3733801

21. Oe K, Iida H, Kobayashi F, Ueda N, Nakamura T, Okamoto N, Saito T (2018) Reattachment of an osteotomized greater trochanter in total hip arthroplasty using an ultra-high molecular weight polyethylene fiber cable. J Orthop Sci 23(6):992-999. https://doi.org/10.1016/j.jos.2018.07.020

22. Ochi H, Homma Y, Baba T, Nojiri H, Matsumoto M, Kaneko K (2017) Sagittal spinopelvic alignment predicts hip function after total hip arthroplasty. Gait Posture 52:293-300. https://doi.org/10.1016/j.gaitpost.2016.12.010

23. Lan RH, Bell JW, Samuel LT, Kamath AF (2021) Outcome measures in total hip arthroplasty: have our metrics changed over 15 years? Arch Orthop Trauma Surg. https://doi.org/10.1007/s00402-021-03809-z

24. Lyman S, Lee YY, McLawhorn AS, Islam W, MacLean CH (2018) What are the minimal and substantial improvements in the HOOS and KOOS and JR versions after total joint replacement? Clin Orthop Relat Res 476(12):2432-2441. https://doi.org/10.1097/corr.0000000000000456

25. Siljander MP, McQuivey KS, Fahs AM, Galasso LA, Serdahely KJ, Karadsheh MS (2018) Current trends in patient-reported outcome measures in total joint arthroplasty: a study of 4 major orthopaedic journals. J Arthroplasty 33(11):3416-3421. https://doi.org/10.1016/j.arth.2018.06.034

26. Vaz G, Roussouly P, Berthonnaud E, Dimnet J (2002) Sagittal morphology and equilibrium of pelvis and spine. Eur Spine J 11(1):80-87. https://doi.org/10.1007/s005860000224

27. Schwab F, Lafage V, Patel A, Farcy JP (2009) Sagittal plane considerations and the pelvis in the adult patient. Spine (Phila Pa 1976) 34(17):1828-1833. https://doi.org/10.1097/brs.0b013e3181a13c08

28. Koo TK, Li MY (2016) A guideline of selecting and reporting intraclass correlation coefficients for reliability research. J Chiropr Med 15:155-63. https://doi.org/10.1016/j.jcm.2016.02.012

29. Perronne L, Haehnel O, Chevret S, Wybier M, Hannouche D, Nizard R, Bousson V (2021) How is quality of life after total hip replacement related to the reconstructed anatomy? A study with low-dose stereoradiography. Diagn Interv Imaging 102(2):101-107. https://doi.org/10.1016/j.diii.2020.05.004
Tables

Table 1
Baseline characteristics and comparison of the disability and control groups

|                      | Disability group n = 30 | Control group n = 178 | P value |
|----------------------|-------------------------|-----------------------|---------|
| Age (years)          | 74.9 ± 7.1              | 74.2 ± 7.3            | .745    |
| Male (n, %)          | 4, 13.3                 | 21, 11.8              | >.999   |
| Body height (cm)     | 153.1 ± 3.1             | 156.7 ± 4.3           | .020*   |
| Body height <148 cm (n, %) | 6, 20.0              | 12, 6.7               | .042*   |
| Body mass index (kg/m²) | 25.3 ± 3.1            | 24.5 ± 3.1            | .723    |
| Prevalent vertebral fractures (n, %) |                      |                       |         |
| 0                    | 22, 73.3                | 144, 80.9             | .807    |
| 1                    | 6, 20.0                 | 29, 16.3              |         |
| 2+                   | 2, 6.7                  | 5, 2.8                |         |
| Surgeons' experience (n, %) |                      |                       |         |
| <8 years             | 2, 6.7                  | 6, 3.4                | .530    |
| 8-15 years           | 16, 53.3                | 76, 42.7              |         |
| >15 years            | 12, 40.0                | 96, 53.9              |         |
| Modified Harris Hip Scorea, b |                    |                       | .544    |
|                      | 49.2 ± 12.8             | 53.4 ± 13.1           |         |
|                      | 66.2 ± 7.8              | 91.7 ± 6.9            | .038*   |
| Visual analogue scale-pain (mm) b |                |                       | .352    |
|                      | 22.7 ± 13.2             | 16.9 ± 13.1           |         |
| Visual analogue scale-satisfaction (mm) b |      |                       | .611    |
|                      | 84.1 ± 14.3             | 75.1 ± 13.7           |         |
|                      | 55.9 ± 12.3             | 14.9 ± 13.1           | .033*   |
| HOOS-JRb             | 48.1 ± 13.8             | 45.9 ± 13.6           | .917    |
|                      | 52.8 ± 16.1             | 87.5 ± 14.3           | .010*   |
| EuroQol 5-Dimensionb | 0.43 ± 0.17             | 0.43 ± 0.11           | .894    |
|                      | 0.63 ± 0.12             | 0.70 ± 0.12           | .125    |
| Trendelenburg sign (n, %) b |                    |                       | .948    |
|                      | 8, 26.7                 | 43, 24.2              |         |
|                      | 6, 20.0                 | 7, 3.9                | .003*   |
| C7 sagittal vertical axis (mm)b |                |                       | .763    |
|                      | 25.1 ± 31.9             | 22.8 ± 33.5           |         |
|                      | 27.0 ± 31.7             | 25.2 ± 32.9           | .648    |
| Pelvic incidence minus lumbar lordosis (°) b |          |                       | .027*   |
|                      | 11.7 ± 11.7             | -5.7 ± 10.7           |         |
|                      | 8.5 ± 12.1              | -3.3 ± 10.1           | .265    |
| T1 pelvic angle divided by pelvic incidenceb |                |                       | .018*   |
|                      | 0.32 ± 0.11             | 0.18 ± 0.09           |         |
|                      | 0.34 ± 0.14             | 0.21 ± 0.08           | .023*   |
| Complication at the reattached fragment c |                      |                       | .016*   |
| Total, (n, %)        | 7, 23.3                 | 13, 7.3               | .692    |
| Type I: II: III (n)  | 2: 3: 2                 | 8: 4: 1               |         |

Data are expressed as mean ± standard deviation or the number of hip involvement (%) as appropriate for the data type.

*P < .05; represents significant between-group differences.

HOOS-JR, the Hip Disability and Osteoarthritis Outcome Score Joint Replacement

aComposite measure covering pain and function, scored on a scale ranging from 0 to 100, with a higher value representing improved function and decreased pain.

bBetween-group comparisons of outcomes pre-operatively (upper row) and at the two-year follow-up (lower row).

cTip and base fractures of the greater trochanter for Types I and II, respectively; and a migration of the osteotomized fragment for Type III [21].
Table 2
Univariate and multivariate logistic regression analyses of the risk factors for persistent disability after total hip arthroplasty defined by the Hip Disability and Osteoarthritis Outcome Score Joint Replacement <70/100

|                          | Univariate analysis | Multivariate analysis |
|--------------------------|---------------------|-----------------------|
|                          | P-value             | Odds ratio 95% CI     |
| Age                      | .684                |                       |
| Male                     | > .999              |                       |
| Body height              |                     |                       |
| ≥148 cm                  | Reference           |                       |
| <148 cm                  | .074*               | 1.26 1.09 – 1.48      |
| Body mass index          | ≥25                 | Reference             |
| <25                      | .746                |                       |
| Surgeons’ experience     | ≥15 years           | Reference             |
|                         | > .999              |                       |
|                         | 8 to 15 years       | > .999                |
|                         | <8 years            | .174*                 |
|                         | 1.13 0.86 – 1.66    |
| T1PA/PI                 | ≤0.2                | Reference             |
|                         | .012*               | 2.11 1.19 – 4.14      |
|                         | >0.2                |                       |

Statistically significant P-values are in boldface.

CI, confidence interval; T1PA/PI, T1 pelvic angle divided by pelvic incidence

*P < .2, statistically significant.

**P < .05, statistically significant.

Table 3
Between-group comparisons of the pre-existence of global sagittal deformity

|                          | T1 pelvic angle divided by pelvic incidence |
|--------------------------|-------------------------------------------|
|                          | >0.2 n = 36 | ≤0.2 n = 172 | P-value |
| Age (years)              | 74.1 ± 6.7 | 74.3 ± 7.1 | .653 |
| Male (n, %)              | 5, 13.9 | 20, 11.6 | .922 |
| Body height (cm)         | 154.1 ± 3.9 | 156.6 ± 3.3 | .021* |
| Body mass index (kg/m²)  | 24.2 ± 3.6 | 24.7 ± 2.9 | .548 |
| Visual analogue scale-satisfaction (mm) | 76.1 ± 17.7 | 76.5 ± 19.4 | .999 |
|                          | 27.2 ± 20.4 | 19.5 ± 18.3 | < .001* |
| HOOS-JR b                | 46.1 ± 12.9 | 46.2 ± 15.2 | .773 |
|                          | 71.2 ± 11.7 | 84.9 ± 12.6 | .023* |
| EuroQol 5-Dimension b    | 0.42 ± 0.13 | 0.43 ± 0.12 | .564 |
|                          | 0.66 ± 0.11 | 0.70 ± 0.12 | .065 |
Data are expressed as mean ± standard deviation values or the number of hip involvements (%) as appropriate for the data type.

*P < .05; represents significant between-group differences.

*HOOS-JR*, the Hip Disability and Osteoarthritis Outcome Score Joint Replacement

*Patient satisfaction after THA evaluated using a 100-mm VAS for satisfaction with anchors at “0” mm (complete satisfaction) and “100” mm (complete dissatisfaction).

*Between-group comparisons of outcomes pre-operatively (upper row) and at the 2-year follow-up (lower row).

**Table 4**

| Intra- and inter-observer reliability of the sagittal spinopelvic parameters evaluated using intra- and inter-class correlation coefficients |
|---|---|---|---|---|
| **C7 sagittal vertical axis** | **Lumbar lordosis** | **Pelvic incidence** | **T1 pelvic angle** |
| **Intra-class Correlation Coefficient** | | | | |
| Observer 1 | 0.71 (0.61 – 0.83) | 0.72 (0.58 – 0.81) | 0.74 (0.61 – 0.84) | 0.77 (0.61 – 0.85) |
| Observer 2 | 0.67 (0.52 – 0.82) | 0.69 (0.62 – 0.84) | 0.73 (0.67 – 0.86) | 0.76 (0.64 – 0.83) |
| Observer 3 | 0.70 (0.64 – 0.82) | 0.71 (0.65 – 0.87) | 0.72 (0.64 – 0.87) | 0.78 (0.63 – 0.82) |
| **Inter-class Correlation Coefficient** | 0.67 (0.55 – 0.76) | 0.63 (0.53 – 0.74) | 0.74 (0.58 – 0.83) | 0.80 (0.61 – 0.84) |

Values are given as coefficients with a corresponding 95% confidence interval in parentheses.