Article

Radiographic Evaluation of Femoral Offset Reconstruction in Hip Arthroplasty: A Retrospective Analysis

Ann. Ital. Chir., 2025 96, 11: 1487–1493
https://doi.org/10.62713/aic.4334

Weixuan Zheng[1], Chengsheng Wu[2], Hongmei Xu[3]

[1]Department of Radiology, Wuyi County Traditional Chinese Medicine Hospital, 321200 Jinhua, Zhejiang, China
[2]Department of Orthopedics, Wuyi County Traditional Chinese Medicine Hospital, 321200 Jinhua, Zhejiang, China
[3]B-ultrasound Room, Wuyi County Traditional Chinese Medicine Hospital, 321200 Jinhua, Zhejiang, China

AIM: To investigate the impact of femoral offset (FO) reconstruction on postoperative hip function recovery and complication rates following total hip arthroplasty (THA) via the posterolateral approach.
METHODS: A retrospective analysis was performed on 146 patients who underwent primary unilateral THA between January 2019 and April 2024. Patients were divided into two groups based on whether the postoperative FO difference ($\leq$4 mm vs. >4 mm): the reconstruction group (n = 92) and the control group (n = 54). Baseline characteristics, radiographic parameters, postoperative functional outcomes (Harris Hip Score (HHS), visual analogue scale (VAS) for pain, and gait parameters), complications, and prosthesis failure cases were compared between the groups, accompanied by a representative case analysis.
RESULTS: No significant differences were observed in baseline data between the two groups ($p > 0.05$). Compared with the control group, the postoperative FO in the reconstruction group was significantly closer to that of the contralateral healthy side ($p < 0.05$). There were no significant differences in acetabular prosthesis parameters between the two groups ($p > 0.05$). However, the femoral stem neck-shaft angle in the control group was significantly smaller than in the reconstruction group ($p < 0.05$). At all postoperative time points, the reconstruction group demonstrated superior outcomes in HHS, VAS, and gait parameters than the control group ($p < 0.05$). The incidence of complications was significantly lower in the reconstruction group than that in the control group ($p < 0.05$), whereas no significant difference was found in prosthesis revision rates ($p > 0.05$). Representative cases indicated that patients who failed to achieve FO reconstruction criteria were more susceptible to postoperative dislocation.
CONCLUSIONS: Precise femoral offset reconstruction contributes to improved postoperative hip function and a reduced risk of complications in THA.

Keywords: total hip arthroplasty; femoral offset; postoperative function; complications

Introduction

Total hip arthroplasty (THA) is one of the most effective treatments for advanced hip joint diseases and is widely used in clinical practice [1]. Approximately 400,000 THA procedures are performed annually in China, and this number continues to increase with population aging and rising expectations for quality of life [2]. Therefore, in-depth investigation of the key factors influencing postoperative outcomes of THA, as well as optimization of surgical techniques and prosthesis selection, remains a central focus of orthopedic research.

In recent years, an increasing number of studies have emphasized optimizing THA surgical techniques to improve surgical outcomes, among which reconstruction of femoral offset (FO) is recognized as one of the critical determinants [3,4]. FO is defined as the vertical distance from the center of the femoral head to the longitudinal axis of the femoral shaft, and its reconstruction directly influences the lever arm length of the hip abductor muscles, the distribution of joint contact stress, and overall joint stability [5–7]. Through the combination of preoperative medical imaging and intraoperative assessment of soft tissue tension around the hip joint, personalized reconstruction of OF can be achieved [8,9]. Theoretically, restoring the normal FO improves the strength of the hip abductor muscles, reduces prosthesis wear, and lowers the risk of postoperative dislocation [10,11]. However, in clinical practice, due to errors in preoperative measurement, inappropriate prosthesis selection, or intraoperative technical deviations, the FO of 15–30% of patients is often inadequately reconstructed [12,13]. Therefore, this study aimed to investigate the impact of FO reconstruction on postoperative functional recovery and complication rates following THA through a retrospective analysis of clinical data and imaging parameters, providing radiographic evidence to guide surgical planning and optimization.

Submitted: 2 September 2025 Revised: 25 September 2025 Accepted: 14 October 2025 Published: 10 November 2025
Correspondence to: Hongmei Xu, B-ultrasound Room, Wuyi County Traditional Chinese Medicine Hospital, 321200 Jinhua, Zhejiang, China (e-mail: 13566930726@163.com).

Materials and Methods

Participants

A total of 146 patients who underwent primary and unilateral THA at Wuyi County Traditional Chinese Medicine Hospital between January 2019 and April 2024 were retrospectively included. Patients were divided into the reconstruction group (femoral offset difference $\leq$4 mm, n = 92) and the control group (femoral offset difference >4 mm, n = 54) based on whether postoperative FO was adequately restored. Inclusion criteria: (1) Age $\geq$18 years; (2) Diagnosis of end-stage hip joint disease; (3) Body mass index (BMI) <30 kg/m^2; (4) Use of the posterolateral surgical approach; (5) Application of a biological femoral prosthesis; (6) Minimum postoperative follow-up $\geq$1 year. Exclusion criteria: (1) Revision surgery; (2) Bilateral simultaneous THA; (3) Presence of neuromuscular disorders, previous hip fractures, severe osteoporosis, or other diseases compromising hip joint mechanics; (4) Presence of cognitive dysfunction or inability to cooperate with postoperative follow-up. This study was approved by the Ethics Committee of Wuyi County Traditional Chinese Medicine Hospital (No. 2025-LL-002) and strictly adheres to the Declaration of Helsinki. Written informed consent was obtained from all participants.

Procedure of Surgery

All patients underwent surgery through the posterolateral approach. The patient was positioned in the lateral decubitus position. After general anesthesia or epidural anesthesia was achieved, a 10–15 cm incision was made, centered on the posterior border of the greater trochanter. The skin, subcutaneous tissue, and fascia lata were incised sequentially, and the gluteus maximus fibers were bluntly separated to expose the short external rotator muscles. The piriformis, obturator internus, superior and inferior gemellus, and other short external rotator muscles were detached and retracted medially to expose the hip joint capsule. The joint capsule was incised in a T-shape, and the hip joint was dislocated to expose the femoral head and acetabulum. The acetabular labrum, ligamentum teres, and hyperplastic synovial tissue were excised. The acetabulum was sequentially reamed with an acetabular rasp until punctate bleeding from the subchondral bone appeared, after which an appropriately sized acetabular prosthesis and liner were implanted.

The femoral side was then prepared: the medullary canal was reamed to an appropriate size, and the biological femoral stem and prosthetic femoral head were implanted, followed by reduction of the hip joint. The range of motion and stability of the hip joint were assessed, the wound was irrigated, a drainage tube was inserted, and the incision was sutured layer by layer. All procedures were performed by the same surgical team.

Methods for Measuring Femoral Offset

FO was defined as the perpendicular distance from the center of the femoral head to the longitudinal axis of the femoral shaft. Measurements were performed using preoperative and postoperative anteroposterior pelvic radiographs. The specific measurement procedure was as follows: the center of the femoral head was determined by drawing two chords across the acetabular arc, followed by erecting perpendicular bisectors to each chord; their intersection point was taken as the center of the femoral head. The midline of the femoral shaft was defined as the extension line of the connection between the midpoint of the intercondylar fossa and the center of the femoral head. As shown in Fig. 1, the vertical distance from the center of the femoral head to the midline of the femoral shaft was measured as the FO. Postoperative FO was compared with that of the contralateral (nonoperative) side, and a difference within 4 mm was considered as successful reconstruction of the FO [14].

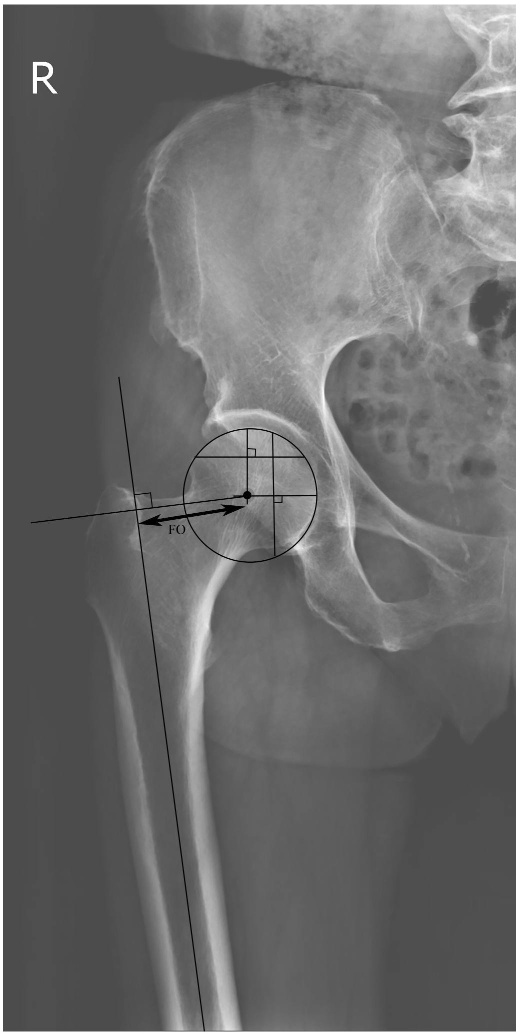

Fig. 1. Measurement of femoral offset. The arrow indicates the length of FO, and circle indicate the femoral head. Note: FO, femoral offset; R, right.

Observation Indicators

Baseline Comparison

Baseline characteristics were compared between the two groups, including gender, age, operative duration, length of hospital stay, and etiology. Radiographic parameters, including acetabular prosthesis positioning and FO measurements (preoperative FO on the affected side, FO on the contralateral side, and postoperative FO), were also analyzed. The difference in femoral offset (DFO) was calculated as: DFO = postoperative FO – FO of the contralateral side.

The acetabular prosthesis position was evaluated by the acetabular abduction and anteversion angles, while the position of the femoral prosthesis was assessed by the femoral stem anteversion angle and the femoral stem neck-shaft angle. Radiographic parameters were measured by two experienced orthopedic radiologists using a double-blind method. Measurements were conducted using RadiAnt DICOM Viewer software (version 2022.1.1; Medixant, Poznan, Poland). To ensure measurement accuracy and reliability, each parameter was measured twice, and the mean value was taken as the final result.

Postoperative Functional Assessment

Patients were followed up for 1 year postoperatively. The Harris Hip Score (HHS) and visual analogue scale (VAS) were used to evaluate the recovery of hip joint function at 3, 6, and 12 months postoperatively. The HHS assesses pain, function, deformity, and joint range of motion, with a maximum score of 100 points. Higher scores indicate better hip joint function [15]. The VAS evaluates pain intensity, ranging from 0 (no pain) to 10 points (severe pain) [16]. Gait performance was assessed at 12 months postoperatively using a gait analyzer (Model 7.7, Tekscan Inc., South Boston, MA, USA). The parameters evaluated included step length, walking speed, and double support duration [17].

Complications and Prosthesis Failure Cases

The incidence of postoperative complications, including dislocation, infection, loosening, and lower limb length discrepancy, was compared between groups. The number of patients requiring prosthesis revision during follow-up was recorded, and prosthesis failure cases were calculated accordingly.

Statistical Methods

Data were analyzed using SPSS 22.0 statistical software (IBM Corp., Armonk, NY, USA). The Shapiro-Wilk test was applied to assess the normality of the data distribution. Measurement data were expressed as mean ± standard deviation ($\bar{x}$ ± s), and comparisons between the two groups were performed using the independent-samples t-test. Categorical variables were expressed as frequencies and percentages (%), and intergroup comparisons were conducted using the chi-square (χ^2) test. A p-value < 0.05 was considered statistically significant.

Results

Baseline Data

As shown in Table 1, there were no significant differences between the two groups in terms of gender distribution, age, surgical side, length of hospital stay, or operative duration ($p > 0.05$), indicating that both groups of people were comparable in baseline characteristics. The primary etiologies among patients included primary osteoarthritis, rheumatoid arthritis, femoral head necrosis, and other causes (such as post-traumatic arthritis). Chi-square analysis revealed no significant difference in the distribution of etiologies between the two groups ($p > 0.05$), indicating that the composition of etiologies had no confounding effect on the study outcomes.

Radiographic Measurement Results

All patients had preoperative and postoperative distal femoral FO measurements of the affected and unaffected sides. The postoperative distal femoral FO in the reconstruction group (40.8 ± 3.9 mm) was closer to the unaffected side (39.1 ± 3.6 mm), while the distal femoral FO in the control group was excessively restored (43.6 ± 4.3 mm). The DFO between the two groups was significantly smaller in the reconstruction group than in the control group (1.3 ± 0.2 mm vs. 4.3 ± 1.6 mm, $p < 0.001$), suggesting that the distal femoral FO was restored more effectively in the reconstruction group (Table 2).

In addition, radiographic parameters of the acetabulum and femoral components were evaluated. There were no significant differences in acetabular abduction or anteversion between the two groups ($p > 0.05$), suggesting that similar acetabular positioning is unlikely to affect treatment outcomes. However, the femoral stem neck-shaft angle was significantly greater in the reconstruction group than in the control group (133.1° ± 5.8° vs. 130.9° ± 4.2°, $p = 0.016$) (Table 3).

Hip Function Assessment

During postoperative follow-up, hip joint function was assessed using the HHS, VAS, and gait parameters. The reconstruction group exhibited significantly higher HHS scores at all postoperative time points compared with the control group ($p < 0.05$), indicating that accurate FO reconstruction contributes to improved hip function. Similarly, VAS scores in the reconstruction group were significantly lower at all time points ($p < 0.05$), suggesting superior postoperative pain control.

Furthermore, gait analysis using a three-dimensional gait system revealed that the reconstruction group achieved better performance in step length, walking speed, and double support time, demonstrating improved gait symmetry and stability. These findings suggest that accurate FO reconstruction facilitates restoration of normal gait patterns (Table 4).

Table 1. Demographic and clinical characteristics of patients.

Variable	Reconstruction group (n = 92)	Control group (n = 54)	t/χ^2	p-value
Age (years)	62.7 ± 8.1	63.4 ± 7.8	0.511	0.612
Males [n (%)]	49 (53.3%)	28 (51.9%)	0.027	0.867
Surgical side (left/right, n)	42/50	25/29	0.006	0.940
Etiology type [n (%)]			0.276	0.964
Primary osteoarthritis	45 (48.9%)	26 (48.1%)		
Rheumatoid arthritis	12 (13.0%)	8 (14.8%)		
Femoral head necrosis	28 (30.4%)	15 (27.8%)		
Others	7 (7.6%)	5 (9.3%)		
Operation duration (minutes)	98.6 ± 12.4	101.2 ± 14.1	1.162	0.247
Length of hospital stay (days)	10.2 ± 2.5	10.5 ± 2.8	0.669	0.504

Note: Data are presented as mean ± standard deviation or n (%).

Table 2. Radiographic parameters of femoral offset.

Indicator (mm)	Reconstruction group (n = 92)	Control group (n = 54)	t	p-value
FO of the contralateral side	39.1 ± 3.6	38.9 ± 4.2	0.304	0.761
Preoperative FO of the affected side	36.2 ± 4.7	35.8 ± 5.1	0.481	0.631
Postoperative FO	40.8 ± 3.9	43.6 ± 4.3	4.031	<0.001
DFO	1.3 ± 0.2	4.3 ± 1.6	17.791	<0.001

Note: DFO, difference in femoral offset.

Table 3. Radiographic parameters of the acetabular and femoral prostheses.

Parameters (°)	Reconstruction group (n = 92)	Control group (n = 54)	t	p-value
Acetabular abduction angle	42.3 ± 3.2	42.8 ± 3.5	0.880	0.380
Acetabular anteversion angle	18.6 ± 4.1	19.2 ± 3.8	0.877	0.382
Femoral stem anteversion angle	12.3 ± 2.5	12.5 ± 2.7	0.453	0.651
Femoral stem neck-shaft angle	133.1 ± 5.8	130.9 ± 4.2	2.436	0.016

Table 4. Postoperative hip joint function and gait parameters.

Time point	Reconstruction group (n = 92)	Control group (n = 54)	t	p-value
HHS				
3 months after surgery	78.6 ± 6.3	73.2 ± 7.1	4.769	<0.001
6 months after surgery	83.4 ± 5.9	77.8 ± 6.7	5.263	<0.001
12 months after surgery	87.2 ± 5.4	80.3 ± 6.5	6.905	<0.001
VAS				
3 months after surgery	2.1 ± 0.8	2.9 ± 1.1	5.062	<0.001
6 months after surgery	1.5 ± 0.6	2.3 ± 0.9	6.437	<0.001
12 months after surgery	1.1 ± 0.5	1.9 ± 0.7	8.023	<0.001
Gait parameters (12 months postoperatively)				
Step length (cm)	65.3 ± 4.8	59.6 ± 5.2	6.716	<0.001
Walking speed (m/s)	1.12 ± 0.11	0.98 ± 0.13	6.935	<0.001
Double support period (s)	0.22 ± 0.03	0.26 ± 0.04	6.858	<0.001

Note: Data are expressed as mean ± standard deviation. HHS, Harris Hip Score; VAS, visual analogue scale.

Complications and Prosthesis Failure Cases

Postoperative complications occurring within one year after surgery were recorded, including dislocation, infection, loosening, and other related events. Among these, dislocation was more frequently observed in the control group. Overall, the incidence of complications in the control group was significantly higher than in the reconstruction group ($p < 0.05$), suggesting that accurate FO reconstruction helps reduce the risk of postoperative complications. The prosthesis failure cases in the reconstruction group was higher than in the control group. However, the difference did not reach statistical significance ($p > 0.05$, Table 5).

Radiographic Case Analysis

Representative cases from each group were compared. In one patient without postoperative complications (Fig. 2A), the FO of the contralateral side was 40.08 mm, while the

Table 5. Postoperative complications and prosthesis failure cases.

Parameter (n)	Reconstruction group (n = 92)	Control group (n = 54)	χ^2	*p*-value
Complication type				
Dislocation	1	3		
Infection	1	2		
Loosening	1	1		
Leg length discrepancy	2	4		
Others	3	1		
Overall complication rate	8	11	4.097	0.043
Prosthesis failure cases	1	3	1.148	0.284

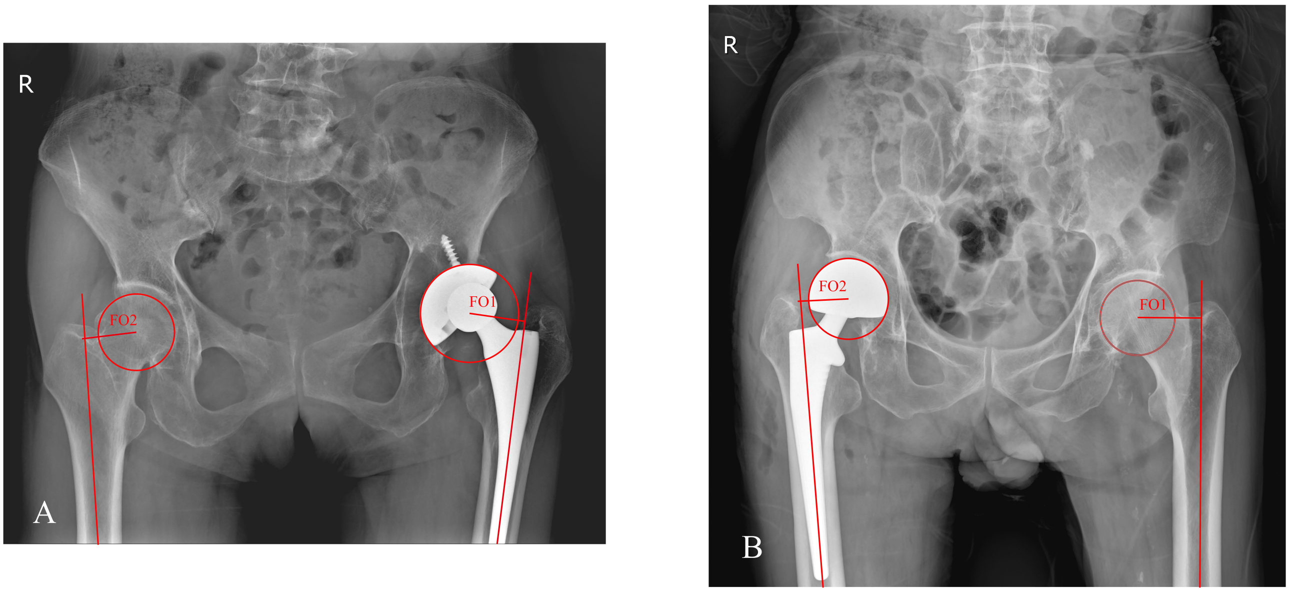

Fig. 2. Representative postoperative radiographs of patients in the two groups. (A) A case showing adequate FO reconstruction in the reconstruction group. (B) A case showing loss of FO reconstruction in the control group. Note: FO, femoral offset; R, right.

postoperative FO of the affected side was 40.88 mm, meeting the reconstruction criteria. In another patient (Fig. 2B), following hip replacement, the FO of the contralateral side was 43.09 mm, while the postoperative FO of the affected side was 37.42 mm. The FO failed to meet the reconstruction criteria, and the patient developed a hip dislocation seven months after surgery.

Discussion

A retrospective analysis of 146 patients who underwent THA via the posterolateral approach in this study revealed that the accuracy of postoperative FO reconstruction significantly influences hip function recovery and pain relief. This finding suggests that achieving precise FO reconstruction during THA is crucial for improving postoperative clinical outcomes.

As a core parameter maintaining the biomechanical balance of the hip joint, the anatomical restoration of FO may affect joint function and prosthesis longevity [18]. A normal FO reduces muscle contraction force by extending the lever arm of the hip abductor muscles. When the offset increases abnormally, the rotational center of the hip joint shifts laterally, resulting in a higher load on the abductor muscles. This increased mechanical demand can lead to muscle fatigue and decreased muscle strength over time [19]. These findings are consistent with the higher incidence of dislocation and lower limb length discrepancy observed in the control group. Notably, no statistical difference was observed in the acetabular abduction or anteversion angles between the two groups, excluding the potential influence of acetabular positioning on the study results ($p < 0.05$). However, there were significant differences in femoral stem neck-shaft angle between the groups, consistent with previous reports indicating that the neck-shaft angle is inversely correlated with FO [20]. This relationship was explained by the fact that when the neck-shaft angle increases, the femoral neck becomes relatively more “upright”, shifting the center of the femoral head toward the longitudinal axis of the femoral shaft and thereby reducing FO. Conversely, when the femoral neck assumes a more “abducted” orientation, FO increases. These findings suggest that adjusting the offset by selecting prostheses with varying neck-shaft angles may represent a feasible clinical strategy.

In this study, the Harris Hip Scores of the reconstruction group at all postoperative time points were significantly higher than those of the control group, while VAS scores remained consistently lower, confirming that effective FO reconstruction can accelerate functional recovery and relieve pain. The mechanism of pain alleviation may relate to optimized joint contact stress: when the offset is close to the physiological levels, load distribution between the acetabular and femoral head prostheses becomes more uniform, reducing pain caused by localized stress concentration [21,22].

Three-dimensional gait analysis further demonstrated that the step length and walking speed of the reconstruction group were significantly superior to those of the control group, and the double support phase was shorter, suggesting that their gait symmetry was close to the normal level. These findings are consistent with the biomechanical evidence showing that abnormal offset delays the transfer of the center of gravity during the gait cycle, compelling patients to extend the double support phase to maintain balance. Moreover, a study by Li *et al*. [23] reported that insufficient offset reconstruction is closely associated with early postoperative gait disorders. In this study, a representative case revealed that a patient who did not meet the reconstruction criteria experienced dislocation seven months postoperatively, further confirming the importance of accurate FO reconstruction for maintaining joint stability.

The results of this study showed that the incidence of postoperative complications in the control group was significantly higher than that in the reconstruction group, with particularly notable differences in dislocation events and lower limb length discrepancies. This finding is consistent with several previous studies. Sakamoto *et al*. [24] reported that FO loss is associated with posterior dislocation following total hip arthroplasty in patients with femoral head osteonecrosis. Similarly, Waibel's study demonstrated that a lower limb length discrepancy exceeding 10 mm can result in pelvic tilt and compensatory lumbar scoliosis, potentially leading to chronic low back pain or prosthesis loosening over time [25]. No significant difference was observed in the prosthesis failure cases between the two groups, which may be related to the relatively short follow-up period.

Although this study reveals the crucial impact of FO reconstruction on postoperative function and complications after THA, several limitations should be acknowledged. First, the sample size was relatively limited. A total of 146 patients were included, which, although somewhat representative, may not sufficiently capture population heterogeneity. Moreover, the unequal sample sizes between groups might have influenced statistical power and the robustness of the conclusions. Second, due to the retrospective design, potential information and selection biases cannot be entirely excluded. Finally, the follow-up period was relatively short, with an average duration of one year, which may not fully reflect the long-term influence of FO reconstruction on the failure cases of the prosthesis.

Future studies should include large-scale, prospective randomized controlled trials to further validate the true impact of FO reconstruction on postoperative outcomes. Additionally, with recent advancements in computer navigation and robot-assisted technologies, numerous studies have demonstrated that these innovations can significantly enhance the precision of FO reconstruction and improve postoperative functional recovery [26,27]. Therefore, integrating imaging evaluation, intraoperative dynamic assessment, and advanced surgical assistance technologies in clinical practice is recommended to optimize the accuracy of FO reconstruction.

Conclusions

In total hip arthroplasty via the posterolateral approach, accurate reconstruction of the femoral offset contributes to improved postoperative hip joint function, reduced pain, enhanced gait stability, and lower risks of postoperative complications.

Availability of Data and Materials

The data analyzed are available from the corresponding author upon reasonable request.

Author Contributions

WXZ and HMX designed the research study and wrote the first draft. WXZ and CSW performed the research. CSW and HMX analyzed the data. All authors have been involved in revising it critically for important intellectual content. All authors gave final approval of the version to be published. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of Wuyi County Traditional Chinese Medicine Hospital (No. 2025-LL-002) and strictly adheres to the Declaration of Helsinki. Written informed consent was obtained from all patients.

Acknowledgment

Not applicable.

Funding

This study is supported by General R&D projects in Wuyi County in 2024 (202418).

Conflict of Interest

The authors declare no conflict of interest.

References

[1] Jensen TM, Pedersen JK, Waldorff FB, Søndergaard J, Overgaard S, Christensen K. Trends in Incidence of Hip Fracture and Hip Replacement in Denmark, 1996 to 2018. JAMA Network Open. 2024; 7: e249186. https://doi.org/10.1001/jamanetworkopen.2024.9186.

[2] Tan Z, Cao G, Wang G, Zhou Z, Pei F. Total hospital cost, length of stay, and complications between simultaneous and staged bilateral total hip arthroplasty: A nationwide retrospective cohort study in China. Medicine. 2019; 98: e14687. https://doi.org/10.1097/MD.0000000000014687.

[3] Meisterhans M, Dimitriou D, Fasser MR, Hoch A, Jud L, Zingg PO. Influence of offset on osseointegration in cementless total hip arthroplasty: A finite element study. Journal of Orthopaedic Research. 2024; 42: 1566–1576. https://doi.org/10.1002/jor.25808.

[4] Kaji ES, Grove AF, Mulford KL, Larson DR, Labott JR, Roman RD, *et al*. The Impact of Leg Length and Offset Change on Dislocation Risk Following Primary Total Hip Arthroplasty. The Journal of Arthroplasty. 2025; 40: 725–731. https://doi.org/10.1016/j.arth.2024.09.009.

[5] Vorimore C, Innmann M, Mavromatis S, Speirs A, Verhaegen JCF, Merle C, *et al*. Impact of Offset and Leg Length on Functional Outcomes Post-Total Hip Arthroplasty: How Accurate Should Coronal Reconstruction Be? The Journal of Arthroplasty. 2024; 39: S332–S339.e2. https://doi.org/10.1016/j.arth.2024.06.017.

[6] Maurer-Ertl W, Friesenbichler J, Pfann M, Maier M, Reinbacher P, Leithner A, *et al*. Restoration of hip geometry after total hip arthroplasty: retrospective comparison of two short stems and one straight stem. BMC Musculoskeletal Disorders. 2022; 23: 1035. https://doi.org/10.1186/s12891-022-05923-4.

[7] Lopes BDM, Spinelli LDF, Galia CR, Schwartsmann CR, Silva MF. Influence of femoral offset on functional capacity of patients with total hip arthroplasty. Acta Ortopedica Brasileira. 2022; 30: e243763. https://doi.org/10.1590/1413-785220223003e243763.

[8] Wasim AS, Tahir M, Ridha A, Sinha A, Hussain S. A Standardised Protocol for Pre-operative Pelvic Radiographs for Templating in Total Hip Arthroplasty. Cureus. 2023; 15: e50687. https://doi.org/10.7759/cureus.50687.

[9] Burzyński S, Sabik A, Witkowski W, Łuczkiewicz P. Influence of the femoral offset on the muscles passive resistance in total hip arthroplasty. PLoS ONE. 2021; 16: e0250397. https://doi.org/10.1371/journal.pone.0250397.

[10] Hidaka R, Matsuda K, Nakamura S, Nakamura M, Kawano H. Clinical effects of combined anteversion and offset on postoperative dislocation in total hip arthroplasty. Arthroplasty. 2024; 6: 22. https://doi.org/10.1186/s42836-024-00245-3.

[11] Hu X, Zheng N, Chen Y, Dai K, Dimitriou D, Li H, *et al*. Optimizing the Femoral Offset for Restoring Physiological Hip Muscle Function in Patients With Total Hip Arthroplasty. Frontiers in Bioengineering and Biotechnology. 2021; 9: 645019. https://doi.org/10.3389/fbioe.2021.645019.

[12] Maitama MI, Lawal YZ, Dahiru IL, Alabi IA, Amaefule KE, Audu SS, *et al*. Implant factors that might influence components' survival in primary total hip arthroplasty. The Nigerian Postgraduate Medical Journal. 2022; 29: 1–5. https://doi.org/10.4103/npmj.npmj_726_21.

[13] Bjarnason JA, Reikeras O. Changes of center of rotation and femoral offset in total hip arthroplasty. Annals of Translational Medicine. 2015; 3: 355. https://doi.org/10.3978/j.issn.2305-5839.2015.12.37.

[14] Vaishy A, Arif M, Aanand R, Singh K, Rulaniya HK, Kumawat N, *et al*. Implant positioning in total hip arthroplasty: influence of horizontal and vertical offset on functionality of prosthetic hip joint. International Orthopaedics. 2022; 46: 1501–1506. https://doi.org/10.1007/s00264-022-05364-7.

[15] Mahomed NN, Arndt DC, McGrory BJ, Harris WH. The Harris hip score: comparison of patient self-report with surgeon assessment. The Journal of Arthroplasty. 2001; 16: 575–580. https://doi.org/10.1054/arth.2001.23716.

[16] Collins SL, Moore RA, McQuay HJ. The visual analogue pain intensity scale: what is moderate pain in millimetres? Pain. 1997; 72: 95–97. https://doi.org/10.1016/s0304-3959(97)00005-5.

[17] Boekesteijn R, Smolders J, Busch V, Keijsers N, Geurts A, Smulders K. Objective monitoring of functional recovery after total knee and hip arthroplasty using sensor-derived gait measures. PeerJ. 2022; 10: e14054. https://doi.org/10.7717/peerj.14054.

[18] Shapira J, Chen SL, Rosinsky PJ, Maldonado DR, Meghpara M, Lall AC, *et al*. The effect of postoperative femoral offset on outcomes after hip arthroplasty: A systematic review. Journal of Orthopaedics. 2020; 22: 5–11. https://doi.org/10.1016/j.jor.2020.03.034.

[19] Oommen AT. Offset restoration in total hip arthroplasty: Important: A current review. World Journal of Orthopedics. 2024; 15: 696–703. https://doi.org/10.5312/wjo.v15.i8.696.

[20] Fang L, Qi J, Wang Z, Liu J, Zhao T, Lin Y, *et al*. Inverse relationship between femoral lateralization and neck-shaft angle is a joint event after intramedullary nailing of per trochanteric fractures. Scientific Reports. 2023; 13: 10999. https://doi.org/10.1038/s41598-023-38209-3.

[21] Budzińska MB, Maciąg BM, Żarnovsky K, Kordyaczny T, Kowalczyk IM, Adamska O, *et al*. How to analyze postoperative radiographs after total hip replacement. Japanese Journal of Radiology. 2023; 41: 14–18. https://doi.org/10.1007/s11604-022-01332-8.

[22] Worlicek M, Messmer B, Grifka J, Renkawitz T, Weber M. Restoration of leg length and offset correlates with trochanteric pain syndrome in total hip arthroplasty. Scientific Reports. 2020; 10: 7107. https://doi.org/10.1038/s41598-020-62531-9.

[23] Li C, Wu D, He W, Wang T, Guo H, Yang Z, *et al*. Loss of walking independence one year after primary total hip arthroplasty for osteonecrosis of the femoral head: incidence and risk prediction model. Journal of Orthopaedic Surgery and Research. 2024; 19: 580. https://doi.org/10.1186/s13018-024-05071-6.

[24] Sakamoto K, Motomura G, Hamai S, Kawahara S, Sato T, Yamaguchi R, *et al*. Radiological factors associated with posterior dislocation after total hip arthroplasty for osteonecrosis of the femoral head - A retrospective study. Journal of Orthopaedics. 2023; 48: 38–41. https://doi.org/10.1016/j.jor.2023.11.015.

[25] Waibel FWA, Berndt K, Jentzsch T, Farei-Campagna J, Rahm S, Dora C, *et al*. Symptomatic leg length discrepancy after total hip arthroplasty is associated with new onset of lower back pain. Orthopaedics & Traumatology, Surgery & Research. 2021; 107: 102761. https://doi.org/10.1016/j.otsr.2020.102761.

[26] Fontalis A, Raj RD, Kim WJ, Gabr A, Glod F, Foissey C, *et al*. Functional implant positioning in total hip arthroplasty and the role of robotic-arm assistance. International Orthopaedics. 2023; 47: 573–584. https://doi.org/10.1007/s00264-022-05646-0.

[27] Lu X, Zhang Z, Xu H, Wang W, Zhang H. A new designed full process coverage robot-assisted total hip arthroplasty: a multicentre randomized clinical trial. International Journal of Surgery. 2024; 110: 2141–2150. https://doi.org/10.1097/JS9.0000000000001103.