

# Short-Term Clinicoradiological Outcomes of Primary Total Hip Arthroplasty With and Without Intraoperative Fluoroscopic Guidance: A Comparative Prospective Non-randomised Controlled (Quasi-experimental) Study

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## Learning Point of the Article:

In experienced hands, intraoperative fluoroscopy helps in improving the accuracy and consistency of acetabular cup inclination during posterolateral THA without altering other radiological or functional outcomes significantly.

## Abstract

**Introduction:** The long-term success of total hip arthroplasty (THA) requires optimal acetabular component positioning. To improve implant placement, intra-operative fluoroscopy is increasingly used, yet the evidence remains limited in the Indian population and confined to the direct anterior approach. This study compares the clinicoradiological outcomes of primary THA performed through the posterolateral approach with and without intraoperative fluoroscopic guidance at a tertiary care institution.

**Materials and Methods:** In this prospective non-randomised controlled (quasi-experimental) study, 70 patients undergoing primary THA between March 2024 and August 2025 were serially allocated, in order of admission, into 2 groups, either fluoroscopy-assisted (n = 35) or freehand technique (n = 35), performed by a single experienced surgeon through the posterolateral approach. Postoperatively, on anteroposterior pelvic radiographs and low-dose computed tomography radiological outcomes (cup inclination, cup anteversion, horizontal femoral offset, distance of cup from teardrop) were measured. Clinical outcomes included operative time, intraoperative blood loss, limb length discrepancy [LLD], dislocation rates and modified Harris Hip score (mHHS) at 6 weeks, 3 months and 6 months follow-up.

**Results:** At baseline, both the study groups were comparable demographically. There was significant improvement in all radiological parameters postoperatively in both study groups. Cup inclination was significantly better in the fluoroscopy group ( $39.92^\circ \pm 3.59^\circ$  vs.  $37.84^\circ \pm 4.44^\circ$ ;  $P = 0.036$ ), with narrow dispersion showing increased consistency. No significant differences were observed in cup anteversion ( $P = 0.699$ ), horizontal femoral offset ( $P = 0.066$ ), LLD ( $P = 0.235$ ), distance from teardrop ( $P = 0.766$ ), dislocation rate ( $P = 1.0$ ), operative time ( $P = 0.147$ ), blood loss ( $P = 0.987$ ), or mHHS at 6 weeks ( $P = 0.735$ ) or 3 months ( $P = 0.204$ ) or 6 months ( $P = 0.669$ ).

**Conclusion:** Intraoperative fluoroscopic guidance during posterolateral THA provides statistically significant improvement in acetabular cup inclination, but there were no measurable advantages in other radiological parameters, short-term functional outcomes, or complication rates when done by an experienced surgeon. Fluoroscopy functions to enhance precision and increases the consistency of component positioning rather than determining outcome in this context.

## Author's Photo Gallery

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**Keywords:** Total hip arthroplasty, fluoroscopy, acetabular cup positioning, cup inclination, Harris hip score, posterolateral approach, limb length discrepancy.

## Introduction

Total hip arthroplasty (THA) is regarded as one of the most successful orthopedics interventions of 20th century, which relieves pain and restores hip function in patients with end-stage hip pathology [1]. The long-term success of THA is dependent heavily on accurate component positioning; malplacement of acetabular cup – deviation from target cup inclination and anteversion is associated with impingement, dislocation, increased poly wear, osteolysis and revision surgery [2, 3].

Historically, Lewinnek et al. defined a radiographic target “safe zone” of  $40^\circ \pm 10^\circ$  inclination and  $15^\circ \pm 10^\circ$  anteversion, to minimise dislocation risk [4]. However, it has been shown that even experienced surgeons using freehand anatomical landmarks technique achieve this zone in <55% of cases, and also that many dislocations still occur within it, which highlights the limitations of purely landmark-dependent technique [5, 6].

Intraoperative fluoroscopy offers real-time visualization of orientation of components, thus providing opportunity for correction of component position before final implantation. Several studies have reported that fluoroscopic guidance reduces outlier cup placement proportion and improvement in limb-length restoration, particularly when used during direct anterior approach (DAA) [7, 8]. However, some studies- case series and meta-analyses have shown no significant difference in mean cup angles, limb length discrepancy (LLD), Dislocation rate or clinical outcomes compared with appropriately executed freehand technique [9, 10].

The majority of the studies are dominated by western cohorts and examined fluoroscopy in THA specifically involving the DAA, which provides a natural table-mounted fluoroscopic workflow. There is a paucity in data comparing fluoroscopy versus freehand technique through the posterolateral approach – the most widely used approach globally – and in India. In addition, Indian population may differ from Western cohorts in terms of anthropometric characteristics, acetabular morphology, etiology (higher proportion of avascular necrosis [AVN] and post-traumatic arthritis), and available surgical infrastructure [11].

To address this gap in current literature, we conducted a comparative prospective observational study at a tertiary referral center in northern India, comparing clinicoradiological outcomes of primary posterolateral THA performed with and without intraoperative C-arm fluoroscopy. Our primary objective was to compare the radiological measurements (cup inclination, cup anteversion, horizontal femoral offset [HFO], distance of cup from teardrop) postoperatively. Secondary

objectives were to compare operative time, blood loss intraoperatively, LLD, dislocation rates and Modified Harris Hip Score (mHHS) at 6 weeks, 3 months and 6 months follow-up.

## Materials and Methods

### Study design, setting and ethics

This study was a single-center, prospective non-randomised controlled (quasi-experimental) study conducted in the Department of Orthopaedics at All India Institute of Medical Sciences (AIIMS), Bilaspur, Himachal Pradesh, India, between March 2024 and August 2025 (18-month enrolment period with a minimum 6-month follow-up for the last enrolled patient). Institutional Ethics Committee approval (Approval Reference No. AIIMS/BLS/IEC-BHR/24-01/CERT/03, dated March 12, 2024) was obtained before commencement of patient enrolment in the study. The study was conducted in accordance with the Declaration of Helsinki (revised 2013) and the ICMR Ethical Guidelines for Biomedical Research on Human Participants (2017). Written informed consent was obtained from all participants matching the inclusion criteria.

### Participants

Patients aged  $\geq 25$  years undergoing primary unilateral THA for end-stage hip pathology who provided written informed consent were eligible. Exclusion criteria were: Periacetabular fractures, revision THA, age <25 years, sequelae of septic hip etiology, acetabular dysplasia (developmental dysplasia of the hip), and refusal of consent. All patients received standard care, and no surgery was performed exclusively for research purposes.

### Sample size

Based on previously published cup inclination data (Summers et al., 2020: mean  $43.85^\circ \pm 7.3^\circ$  vs.  $39.7^\circ \pm 5.7^\circ$ ) [12], a sample size of 31 per group was calculated (90% confidence interval, 80% power, two-sided  $\alpha$ , using EpiInfo 7). Adding 10% for loss to follow-up yielded a target of 35 per group (total  $n = 70$ ).

### Group allocation and surgical technique

Allocation was non-randomized (alternate allocation). Consecutive eligible patients were allocated a serial number in the order of their admission for surgery; patients with odd serial numbers were allocated to the fluoroscopy group (group 1,  $n =$

**Table 1: Baseline demographic and preoperative clinicoradiological comparability of the two groups**

| Parameter                                   | Fluoroscopy<br>(n=35) | Freehand<br>(n=35) | P-value |
|---------------------------------------------|-----------------------|--------------------|---------|
| Age (years),<br>mean±SD                     | 55.58±18.18           | 55.86±18.21        | 0.947   |
| BMI (kg/m <sup>2</sup> ),<br>mean±SD        | 28.17±5.19            | 27.00±5.51         | 0.364   |
| Female sex, n (%)                           | 17 (48.6)             | 23 (65.7)          | 0.827*  |
| Right side, n (%)                           | 18 (51.4)             | 16 (45.7)          | 0.481*  |
| Pre-operative LLD<br>(cm), mean±SD          | 2.50±3.39             | 3.55±3.88          | 0.234   |
| Pre-operative cup<br>anteversion (°)        | 27.45±4.44            | 29.30±4.98         | 0.109   |
| Pre-operative cup<br>inclination (°)        | 44.52±7.11            | 43.94±8.25         | 0.754   |
| Pre-operative horiz.<br>femoral offset (mm) | 44.39±7.47            | 44.31±8.24         | 0.936   |

**LLD: Limb length discrepancy, \*Chi-square test; all others independent t-test**

35) and those with even serial numbers to the freehand group (Group 2, n = 35). The allocation register was maintained by a resident not involved in surgery or outcome assessment, and allocation was fixed before surgery. Patients in both study groups underwent primary THA through the posterolateral approach in the lateral decubitus position, performed by a single surgeon with 10 years of orthopedic experience.

Group 1 (fluoroscopy-assisted): Capsule was preserved and repaired at closure. Intraoperative fluoroscopy was used to confirm the reamer position, medialization, cup inclination, and anteversion using the Widmer method (Anteversion:  $\arcsin [\text{short axis}/\text{total length}]$  from AP fluoroscopic images of the cup). Cup inclination was assessed on the fluoroscopy image with reference to the mid-sagittal plane. First, a neutral-version of cup fluoroscopic image (perfect hemispheric cup projection) was obtained; the cup inserter was then adjusted to achieve target anteversion. The patient was not turned or repositioned at any stage. With the patient held in lateral decubitus position in a pelvic positioner, the C-arm was brought in from the anterior side of the table, and its C-arc rotated through 90° so that the X-ray beam travelled horizontally (parallel to the floor) in an anteroposterior (AP) direction through the pelvis,

giving an AP view of the pelvis with the patient in situ. Before image acquisition, pelvic rotation and tilt were neutralized by adjusting the C-arm (rather than the patient) until the pubic symphysis was aligned with the sacrococcygeal midline and the obturator foramina and teardrops appeared symmetrical. All images were acquired by the operation-theatre radiographer under the direction of the operating surgeon; a mean of 5 images were taken per case.

Group 2 (freehand technique): Partial capsulectomy was performed to permit identification of internal landmarks. The orientation of the acetabular cup was guided by the internal and external anatomical landmarks and a standard external aiming arm; no fluoroscopy was used for the acetabular cup positioning.

Femoral component insertion was done by identical standard steps in both groups with no fluoroscopy use, and the wounds were closed over a drain.

#### Outcome measurements

Radiological outcomes were measured on immediate post-operative AP pelvic radiographs and low-dose computed tomography (CT) of the pelvis (performed identically in both groups, not in one group only), with repeat AP radiographs at 6 weeks, 3 months and 6 months follow-up. CT was included because radiographic anteversion measured by the Widmer method is affected by pelvic tilt and rotation and cannot distinguish anteversion from retroversion, whereas CT is regarded as the reference standard for measuring cup orientation. To minimise radiation exposure in keeping with the ALARA principle, a single low-dose pelvic protocol (120 kVp, 200–300 mAs; estimated effective dose ~ 10–15 mSv) was used, and no additional CT was performed during follow-up. The scan was part of the protocol approved by the Institutional Ethics Committee, was explained specifically during informed

**Table 2: Intraoperative and perioperative parameters**

| Parameter                                   | Fluoroscopy<br>(n=35) | Freehand<br>(n=35) | P-value |
|---------------------------------------------|-----------------------|--------------------|---------|
| Operative time (min),<br>mean±SD            | 103.91±25.59          | 95.19±24.13        | 0.147   |
| Intra-operative blood<br>loss (mL), mean±SD | 403.67±166.90         | 404.24±134.88      | 0.987   |
| Drain Day 1 (mL)                            | 181.91±72.47          | 175.62±79.58       | 0.732   |
| Drain Day 2 (mL)                            | 101.33±49.19          | 109.68±50.85       | 0.489   |
| Drain Day 3 (mL)                            | 73.00±42.52           | 72.16±39.36        | 0.932   |

**Table 3: Post-operative clinicoradiological outcomes**

| Parameter                       | Fluoroscopy (n=35) | Freehand (n=35) | P-value            |
|---------------------------------|--------------------|-----------------|--------------------|
| Cup inclination (°)             | 39.92±3.59         | 37.84±4.44      | 0.036 <sup>†</sup> |
| Cup anteversion (°)             | 12.21±4.28         | 12.61±4.30      | 0.699              |
| Horizontal femoral offset (mm)  | 39.10±3.85         | 37.22±4.49      | 0.066              |
| Post-operative LLD (cm)         | 0.68±0.32          | 0.59±0.27       | 0.235              |
| Distance cup from teardrop (mm) | 6.66±3.21          | 6.89±3.18       | 0.766              |
| Dislocation, n (%)              | 1 (2.9)            | 1 (2.9)         | 1.000*             |

<sup>†</sup>Statistically significant; \*Fisher's exact test, LLD: Limb length discrepancy

consent, and was performed at no additional cost to the patient.

Cup inclination was measured as the angle between the transverse axis joining both ischial tuberosities and the plane of the acetabular opening on AP radiographs.

Cup anteversion was measured using the Widmer method on AP radiographs of the pelvis ( $\arcsin [S/TL]$ , where S = short axis and TL = total length of the cup's projected ellipse) and on axial CT sections (angle between the line perpendicular to the line connecting cup centres bilaterally and a line touching the AP edges of the cup).

HFO was measured as the perpendicular distance between the center of rotation of the hip and the proximal femoral shaft anatomical axis.

Distance of cup from teardrop was the horizontal distance between the ipsilateral teardrop and the most medial margin of the acetabular component.

LLD was measured on AP pelvic radiographs at 6 weeks as the difference between perpendicular distances from the inter-teardrop line to the lesser trochanteric apex bilaterally.

### Clinical outcomes

LLD was measured from ASIS to medial malleolus with limbs in identical position and squared pelvis, mHHS was recorded preoperatively and at 6 weeks, 3 months, and 6 months postoperatively. Dislocation, operative time (skin incision to skin closure), intraoperative blood loss (suction container + swab weighing), and drain output on post-operative days 1–3 were also documented.

### Statistical analysis

Data were entered into Microsoft Excel and analysed using EpiInfo 7. Continuous variables were tested for normality (Shapiro–Wilk) and reported as mean ± standard deviation. Categorical variables were reported as numbers and percentages. Independent-samples t-test compared continuous variables between groups; Chi-square or Fisher's exact test compared categorical variables. Paired-samples t-test compared pre- versus post-operative parameters within groups. Repeated-measures analysis of variance was applied where >2 time-points were compared. A two-tailed  $P < 0.05$  was considered statistically significant.

## Results

### Patient demographics and baseline characteristics

Seventy patients were enrolled and followed for a minimum of 6 months (short-term follow-up). The study population comprised 40 females (57.14%) and 30 males (42.86%), age ranging from below 40 to over 80 years (overall  $\chi^2$  for age–gender association: 11.65,  $P = 0.039$ ; reflecting unequal gender ratios across age strata in the total cohort). Allocation to fluoroscopy or freehand groups was not associated with age or gender ( $\chi^2 = 2.15$ ,  $P = 0.827$ ; Table 1).

Etiological categories were: primary osteoarthritis (27.14%), post-traumatic arthritis (25.71%), AVN (24.29%), inflammatory arthritis (14.29%), and femoral neck fracture (8.57%) – a distribution consistent with the Indian THA demographic ( $\chi^2 = 9.29$ ,  $P = 0.054$ , borderline non-significant for uniform distribution).

### Intraoperative parameters

Operative time was longer in the fluoroscopy group ( $103.91 \pm 25.59$  min vs.  $95.19 \pm 24.13$  min), but there was no significant statistical difference ( $P = 0.147$ ). Intraoperative blood loss was identical between groups ( $403.67 \pm 166.90$  mL vs.  $404.24 \pm 134.88$  mL;  $P = 0.987$ ). Post-operative drain output on days 1, 2,

**Table 4: Pre-operative versus post-operative parameters in both groups**

| Parameter                       | Fluoro pre-operative | Fluoro post-operative | P-value | Freehand pre-operative | Freehand post-operative | P-value |
|---------------------------------|----------------------|-----------------------|---------|------------------------|-------------------------|---------|
| LLD (cm)                        | 2.50±3.39            | 0.68±0.32             | 0.004   | 3.55±3.88              | 0.59±0.27               | <0.001  |
| Cup anteversion (°)             | 27.45±4.44           | 12.21±4.28            | <0.001  | 29.30±4.98             | 12.61±4.30              | <0.001  |
| Cup inclination (°)             | 44.52±7.11           | 39.92±3.59            | 0.001   | 43.94±8.25             | 37.84±4.44              | <0.001  |
| Horizontal. Femoral offset (mm) | 44.39±7.47           | 39.10±3.85            | 0.002   | 44.31±8.24             | 37.22±4.49              | <0.001  |

**Table 5: Modified Harris Hip score at 6 weeks, 3 months and 6 months postoperatively**

| Time point                                                                                                                                            | Fluoroscopy<br>(n=35) | Freehand<br>(n=35) | P-value |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--------------------|---------|
| 6 weeks post-operative                                                                                                                                | 73.30±9.04            | 73.95±6.76         | 0.735   |
| 3 months post-operative                                                                                                                               | 83.52±5.53            | 85.00±4.12         | 0.204   |
| 6 months                                                                                                                                              | 89.58±4.27            | 89.97±3.45         | 0.669   |
| <b>Within-group improvement across all three time points <math>P &lt; 0.001</math> for both groups (one-way analysis of variance and paired-test)</b> |                       |                    |         |

and 3 showed no significant between-group difference (all  $P > 0.05$ ; Table 2).

### Post-operative radiological outcomes

The primary finding was a statistically significant difference in post-operative cup inclination: the fluoroscopy group achieved a mean inclination of  $39.92^\circ \pm 3.59^\circ$  compared with  $37.84^\circ \pm 4.44^\circ$  in the freehand group ( $P = 0.036$ ). Both values fell within the Lewinnek safe zone ( $30^\circ$ – $50^\circ$ ); however, the fluoroscopy group's mean was closer to the commonly cited ideal of  $40^\circ$ – $45^\circ$ , and the narrower standard deviation reflected greater consistency. No significant between-group differences were observed for cup anteversion, HFO, post-operative LLD, or distance of cup from teardrop (Table 3). Dislocation occurred in one patient per group (1.43% each;  $P = 1.0$ ).

### Pre- to post-operative improvement

Both groups demonstrated highly significant pre- to post-operative improvements across all radiological parameters ( $P < 0.01$  for all comparisons in both groups; Table 4). LLD improved from  $2.50 \pm 3.39$  cm to  $0.68 \pm 0.32$  cm (fluoroscopy) and from  $3.55 \pm 3.88$  cm to  $0.59 \pm 0.27$  cm (freehand). Cup anteversion corrected from approximately  $27$ – $29^\circ$  preoperatively to  $\sim 12^\circ$  postoperatively in both groups. The magnitude and significance of improvement were similar between techniques, underscoring that THA itself – rather than the use of fluoroscopy – is the primary determinant of anatomical restoration.

### Functional outcomes

mHHS was assessed at 3 post-operative times: 6 weeks, 3 months, and 6 months. Results are presented in Table 5. mHHS improved substantially from baseline in both groups. At 6 weeks, mean mHHS was  $73.30 \pm 9.04$  (fluoroscopy) versus  $73.95 \pm 6.76$  (freehand;  $P = 0.735$ ). At 3 months, scores were  $83.52 \pm 5.53$  versus  $85.00 \pm 4.12$ , respectively ( $P = 0.204$ ). At 6

months, scores were  $89.58 \pm 4.27$  (fluoroscopy) and  $89.97 \pm 3.45$  (freehand) ( $P = 0.669$ ). No statistically significant difference in functional recovery was observed between groups at either time point (Table 5 & 6).

### Discussion

The principal finding of this prospective comparative study is that intraoperative fluoroscopic guidance during posterolateral THA resulted in a statistically significant improvement in acetabular cup inclination accuracy – with a mean of  $39.92^\circ$  in the fluoroscopy group compared with  $37.84^\circ$  in the freehand group ( $P = 0.036$ ) – and, importantly, reduced intra-group variability (SD  $3.59^\circ$  vs.  $4.44^\circ$ ). Both values were within the Lewinnek safe zone, yet the fluoroscopy group's mean was closer to the generally preferred  $40^\circ$ – $45^\circ$  range associated with lower polyethylene wear. These findings are consistent with those of Beamer et al., who reported that fluoroscopy improved placement within the safe zone (65% vs. 44%; odds ratio 2.3), and with Belyea et al., who found significantly better cup inclination in posterior THA performed with versus without fluoroscopy ( $44^\circ$  vs.  $50^\circ$ ;  $P < 0.05$ ) [13, 14]. In contrast, cup anteversion, HFO, post-operative LLD, and distance of cup from teardrop did not differ significantly between groups. This is consistent with the meta-analysis of Sun et al. (7 studies, 1,262 hips), which found no significant benefit of fluoroscopy for inclination, anteversion, safe-zone achievement, or LLD in DAA-THA. Similarly, Lecoultre et al. (10 studies, 1,394 patients) found no significant difference between fluoroscopic and freehand techniques in inclination, anteversion, offset, LLD, or revision rates [15, 16]. Our findings of equivalent cup anteversion in both groups accord with two possible mechanisms: first, anteversion is primarily controlled by the spatial orientation of the inserter arm relative to the surgeon's reference axis, a tactile and proprioceptive skill less amenable to real-time correction; second, the Widmer method used fluoroscopically requires accurate pelvic alignment and may systematically under-read anteversion by approximately  $4^\circ$ – $5^\circ$  compared with post-operative CT, as reported by Li et al.

**Table 6: mHHS outcome grading at 6-month follow-up**

| Grade     | mHHS range | Fluoroscopy n (%) | Freehand n (%) |
|-----------|------------|-------------------|----------------|
| Excellent | $\geq 90$  | 19 (54.5)         | 18 (51.4)      |
| Good      | 80–89      | 16 (45.5)         | 17 (48.6)      |
| Fair      | 70–79      | 0 (0.0)           | 0 (0.0)        |
| Poor      | $< 70$     | 0 (0.0)           | 0 (0.0)        |

**mHHS: modified Harris Hip score**

[17].

The lack of significant difference in LLD is noteworthy and aligns with Bingham et al. and Brown et al., both of which found no meaningful fluoroscopy benefit for LLD in comparable settings [10, 18]. In our study, both groups achieved clinically satisfactory LLD correction (mean  $\leq 0.7$  cm postoperatively vs.  $> 2.5$  cm preoperatively), with no significant between-group difference. This suggests that LLD correction in posterolateral THA is largely governed by the accuracy of femoral neck osteotomy level, trial reduction assessment, and templating – factors common to both groups. The significant benefit of fluoroscopy for LLD reported by Blum et al. was observed specifically with the anterior-based muscle-sparing approach in the supine position, where table-mounted fluoroscopy affords standardised pelvic reference; this advantage may not translate to the lateral decubitus posterolateral approach [7].

Operative time was 8.7 min longer in the fluoroscopy group, though this was not statistically significant ( $P = 0.147$ ). This is smaller than the 18-min difference reported by Johns et al. and is probably attributable to an institutional learning curve already having been traversed [19]. Fluoroscopy did not increase intraoperative blood loss, post-operative drain output, or dislocation rate – confirming the safety of its integration into the surgical workflow.

Functional recovery as measured by mHHS was high in both groups and statistically equivalent at 6 weeks, 3 months, and 6 months. This finding parallels the limited evidence linking improved cup inclination to short-term patient-reported outcomes, and echoes the conclusions of Vinjamuri et al. and the broader literature showing that short-term mHHS is primarily driven by the quality of pain relief and rehabilitation rather than by small angular differences within the safe zone [20]. Long-term outcome data are required to determine whether the improved inclination consistency in the fluoroscopy group translates into reduced polyethylene wear and revision rates.

An important contextual note is that this study was performed at a high-volume tertiary center by a single surgeon with substantial THA experience. As multiple authors have observed – including Lecoultré et al. and Holst et al. – the benefit of fluoroscopy is likely greater for less experienced surgeons or those earlier on their learning curve [16, 21]. Our findings thus apply to experienced surgeons in well-resourced institutional

settings and should not be extrapolated to situations where the baseline freehand accuracy is lower.

This study has several strengths: Prospective design, standardised single-surgeon technique, preoperative CT-based radiological assessment, serial group allocation minimizing selection bias for demographic factors, and an Indian population cohort – a demographic notably underrepresented in published THA fluoroscopy literature.

### Limitations

Limitations include the 6-month follow-up (insufficient to assess implant survivorship, wear, or loosening), single-center single-surgeon design limiting generalisability, serial rather than randomised allocation (introducing residual performance bias risk), and underpowering for rare outcomes such as dislocation. Furthermore, fluoroscopy was applied only to the acetabular component; femoral preparation was freehand in both groups, which may have diluted detectable differences in composite outcomes such as LLD and overall offset. Furthermore, our study included only primary THA and not revision THA.

### Conclusion

Intraoperative fluoroscopic guidance during posterolateral primary THA offers a statistically significant improvement in acetabular cup inclination accuracy and consistency, aligning placement more precisely with ideal targets and reducing inter-patient variability. However, it shows no significant advantage over experienced freehand technique for cup anteversion, HFO, LLD, dislocation rate, operative time, blood loss, or short-term functional recovery. Fluoroscopy operates as a precision-enhancing adjunct rather than a clinically transformative tool in the hands of experienced surgeons. Its integration into routine posterolateral THA workflow is safe, does not meaningfully prolong operative duration, and may be particularly valuable in complex cases or for surgeons earlier in their learning curve. Longer follow-up studies powered for implant survivorship and wear endpoints are needed to determine whether superior inclination consistency translates into meaningful long-term clinical benefit.

**Declaration of patient consent:** The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

**Conflict of interest:** Nil    **Source of support:** None



### Clinical Message

For experienced surgeons with landmark-based technique by posterolateral THA, intraoperative fluoroscopy can be used to fine-tune acetabular cup inclinations, particularly in cases having complex anatomy, obese patients, revision-prone pathology, or while supervising trainees, without affecting operative time, blood loss, or short-term recovery. Routine fluoroscopy use is not mandatory when freehand technique is used and the safe-zone placement of prosthetic components is achieved, since fluoroscopy alone does not translate into better anteversion control, limb-length restoration, or early functional scores. Surgeons should therefore view fluoroscopy as an adjunct that refines precision rather than a substitute to sound freehand landmark-based surgical technique, reserving it for situations where acetabular cup positioning is less reliable by landmark technique, and also they should not expect it, by itself, to reduce dislocation risk or improve short-term outcomes in experienced hands.

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