Bratislava Medical Journal
https://doi.org/10.1007/s44411-026-00653-8

RESEARCH

A Consistent Intra-Articular Landmark for Safer Transacetabular Screw Placement: A Topographic Cadaveric Study

Bulent Ozkurt[1,2] · Simel Kendir[2,3] · Ali Utkan[1,2] · Suleyman Tuna Karahan[2,3] · Nihal Apaydin[2,3,4]

Received: 7 April 2026 / Revised: 9 May 2026 / Accepted: 12 May 2026
© The Author(s) 2026

Abstract

Background Transacetabular screw fixation enhances initial stability in cementless total hip arthroplasty but risks injury to adjacent neurovascular structures. The junction of the posterior articular surface of the lunate surface and the ischial ramus was identified as a consistent and reproducible intra-articular landmark, and this anatomical study was designed to evaluate its potential use as a reliable guide for screw orientation and to improve surgical safety.

Methods In a two-part study design, including topographic dry-bone morphometry on 50 adult hemipelves and cadaveric dissection in 4 male donors. Acetabular bone thickness and the spatial relationships of simulated screw trajectories to intrapelvic neurovascular structures were mapped. The acetabulum was divided into 12 radial sectors from the landmark, with two levels analyzed along each radius (A: central; B: peripheral), resulting in 24 measurement points.

Results Sectors 5B–7B were characterized by greater bone stock and wider neurovascular clearance, whereas points such as 1 A, 2 A, and 12B were identified as higher-risk regions, with bone thickness < 7 mm and neurovascular proximity ≤ 5 mm. The landmark was consistently visible and easily identifiable following acetabular reaming.

Conclusion These findings support the use of this landmark as a side-independent and intraoperatively accessible reference that may improve anatomical orientation for screw placement, particularly in cases where external landmarks are obscured. Further clinical validation in live surgical settings is warranted to confirm its safety and utility.

Keywords Acetabular cup · Anatomical landmark · Intra-articular landmark · Screw trajectory · Total hip arthroplasty · Transacetabular screw

1 Introduction

Total hip arthroplasty (THA) remains the gold-standard intervention for end-stage hip osteoarthritis when conservative measures fail [1]. Despite advances in implant materials, surfaces, and technique, optimal acetabular component orientation and secure initial fixation are critical to early stability and long-term success [2].

Cementless cups are commonly implanted with a press-fit slightly oversized to the reamed cavity, promoting primary stability, bone ingrowth, physiological load transfer, and reduced micromotion [3]. Although screwless components can yield acceptable outcomes with immediate weight-bearing [4], many surgeons selectively add transacetabular screws in borderline bone quality or complex acetabular morphology [5].

Transacetabular screws, however, pose a risk to adjacent neurovascular (NV) structures (particularly the external iliac vessels, the obturator NV bundle, and the gluteal arteries), so trajectory planning must balance bone stock with avoidance of critical anatomical structures [6–8]. Several frameworks delineate "safe zones," including anatomical/radiological systems [9, 10]. The widely used four-quadrant method by Wasielewski et al. references the anterior superior iliac spine (ASIS); yet reliance on external palpation can

✉ Simel Kendir
simelkendir@yahoo.com

1 Department of Orthopedics and Traumatology, Ankara Bilkent City Hospital, University of Health Sciences, Ankara, Turkey

2 Graduate School of Health Sciences (Clinical Anatomy), Ankara University, Ankara, Turkey

3 Faculty of Medicine, Department of Anatomy, Ankara University, Ankara, Turkey

4 Neuroscience and Neurotechnology Center of Excellence (NOROM), Ankara, Turkey

Published online: 22 May 2026

be unreliable in obesity, altered pelvic morphology, or prior surgery, and external landmarks are often poorly visualized in minimally invasive or revision approaches [11, 12].

Alternative schemes, clock-face mapping [13, 14], intra-articular cues such as the acetabular fossa [15], or tactile guidance from the sciatic notch [16], offer partial solutions but have not achieved widespread adoption due to variable reproducibility and limited intraoperative practicality.

To address these limitations, a novel intra-articular reference point was defined at the junction between the posterior margin of the acetabular lunate surface and the ischial body (corpus ossis ischii), corresponding to the posterior-inferior boundary of the acetabulum. This landmark is side-independent, readily identifiable intraoperatively, and remains visible after reaming, providing a direct intra-articular cue when external landmarks are obscured. Using complementary dry hemipelvis morphometry and cadaveric dissection, local topography was characterized and simulated screw trajectories were mapped relative to adjacent NV structures to refine safe and high-risk zones [17–19]. In this context, the present study was designed to evaluate the anatomical reliability and surgical applicability of this landmark as a reproducible, anatomy-based intra-articular guide for safe screw placement in cementless THA.

2 Methods

2.1 Study Design and Setting

This study was conducted at the Ankara University Faculty of Medicine, Department of Anatomy, and comprised two complementary components: (1) a dry-bone morphometric analysis and (2) a cadaveric dissection-based analysis to assess the spatial relationships between simulated acetabular screw trajectories and intrapelvic NV structures.

2.2 Dry-Bone Morphometric Analysis

Fifty (25 right, 25 left) adult dry hemipelves from the institutional skeletal collection were examined. Side labels were recorded for all hemipelves. Sex-related information for the dry bone specimens was not available in the collection; therefore, no sex-based analysis could be performed. Specimens without gross deformity or post-traumatic/surgical alterations were included. A transparent 360° circular goniometer with a central Kirschner wire (K-wire) sleeve was used to determine the acetabular center (Fig. 1). The acetabular center was defined by fitting a best-fit circle to the acetabular margin; two observers reached consensus on the mark. A digital caliper (iKKEGOL Precision 100 mm 4 Inch Digital Electronic Gauge Stainless Steel Vernier Caliper, 0.1 mm resolution) fitted with a custom three-point contact tip (Fig. 2) ensured measurements were taken perpendicularly to the local acetabular surface to minimize error. The caliper was calibrated before each session; measurement accuracy was ±0.1 mm. Each measurement was performed twice by each of two observers one week apart.

The intra-articular reference landmark was defined at the junction between the posterior margin of the acetabular lunate surface and the ischial body. From this point, the acetabular margin was divided into twelve 30° radial sectors (clockwise for right acetabula, counterclockwise for left), starting at the landmark (sector 1). Along each radius, the rim-to-center line was divided into three equal segments by two internal division points which were designated as A (closer to the center) and B (more peripheral); yielding 24 measurement points in total (Fig. 3a, b). Bone thickness at each point was recorded by two different researchers. Intra- and inter-observer repeatability for acetabular diameter and dry-bone thickness measurements was summarized using intraclass correlation coefficients (ICC) with 95% confidence intervals and interpreted according to Cicchetti's

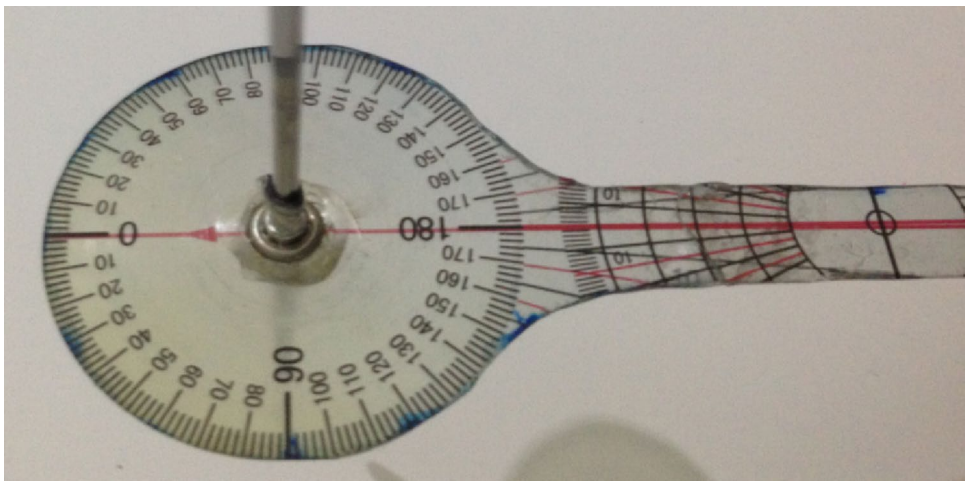


Fig. 1 Transparent 360° circular goniometer equipped with a central Kirschner wire (K-wire) sleeve used to define the acetabular center



Fig. 2 Digital caliper with a custom three-point tip ensuring perpendicular contact with the local acetabular articular surface during thickness measurements

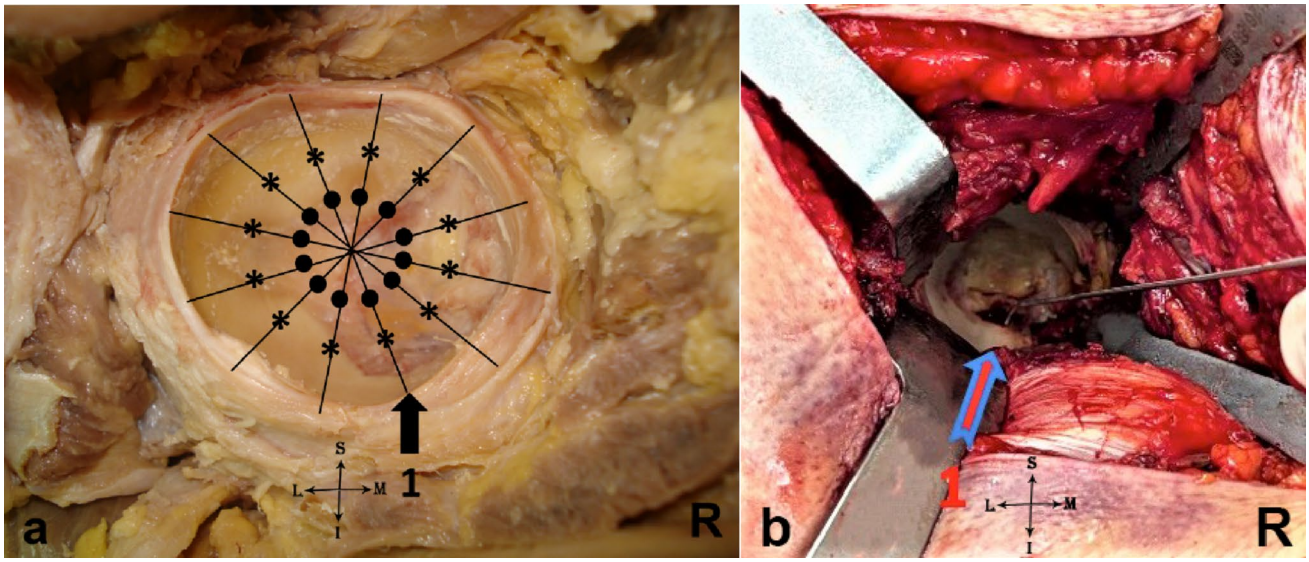


Fig. 3 Junction between the posterior margin of the acetabular lunate surface and the ischial body. R: right side. Directional arrows denote anatomical orientation: S, superior; I, inferior; M, medial; L, lateral. (**a**) Acetabular mapping and measurement framework. Starting clockwise from the posterior lunate-ischial junction (big arrow), the rim is divided into twelve 30° radial sectors. Along each radius, central points are indicated by dots (•, Point A) and peripheral points by asterisks (*, Point B), yielding a total of 24 measurement locations. (**b**) Cadaveric intra-articular view showing the K-wire tip at the same reference point in the right acetabulum

criteria. The acetabular diameter was measured from the external edge of the acetabular margin.

2.3 Cadaveric Dissection-Based Analysis

Both acetabula of four male body donors fixed in 10% formalin (age range 64–71 years) were dissected ($n = 8$ acetabula). Specimens were positioned supine, and the pelvis was immobilized using a custom pelvic clamp (clockvise-like) affixed to the table to prevent motion during trajectory simulation. After disarticulation of the hip joints, external pelvic musculature was removed while preserving intrapelvic NV structures (external and internal iliac vessels, obturator vessels and nerve, sciatic nerve, and superior and inferior gluteal arteries), as well as the obturator internus and parietal peritoneum. None of the specimens exhibited gross osteoarthritic deformity or irregularities of the acetabular surface.

Following sector marking, a central drill hole was created. A U-shaped K-wire was guided perpendicular to the local acetabular surface at the center using a custom acetabular guide. One arm of the wire extended into the acetabulum, and the external arm was sequentially aligned with each radial line to simulate screw trajectories. The corresponding exit points on the inner pelvis were marked with silk sutures (Fig. 4a-c), and the shortest linear distances from exit points to any adjacent NV structures were measured with a digital caliper. Each NV distance was measured twice, the mean value was used for analysis, and distances were taken along the anatomic plane that yielded the shortest linear path.

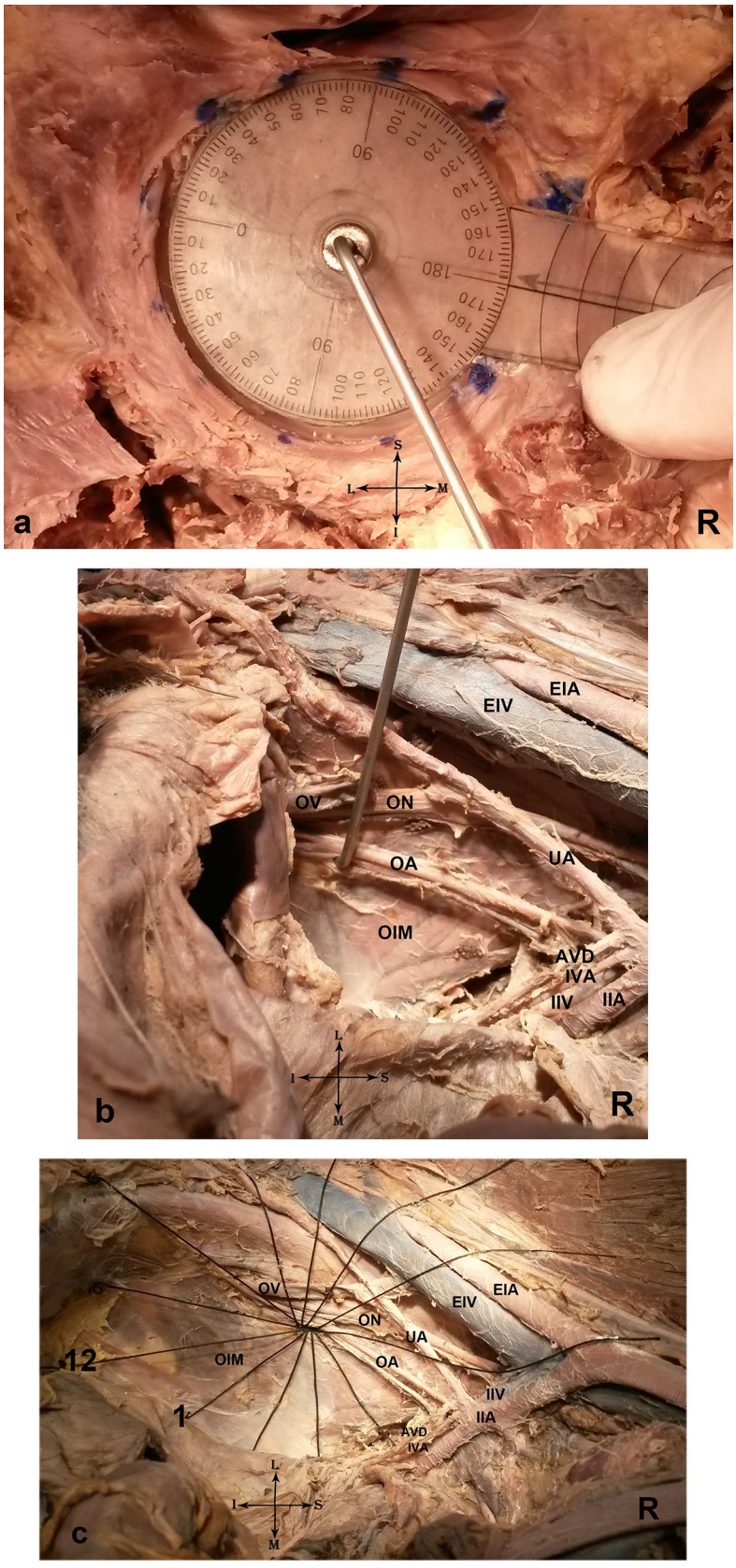


Fig. 4 Simulation of radial screw trajectories in a cadaveric acetabular specimen demonstrating the spatial orientation and distribution of potential screw paths. R: right side. Directional arrows denote anatomical orientation: S, superior; I, inferior; M, medial; L, lateral. (**a**) Determination of the acetabular center using the goniometer and central K-wire. (**b**) Intrapelvic view illustrating acetabular anatomy and the spatial relationship of adjacent neurovascular structures; a K-wire traverses the acetabular center. (**c**) Radial sectors 1–12 are indicated by silk sutures placed within the pelvic cavity to represent simulated exit points, starting from the posterior reference junction. UA: Umbilical Artery, IVA: Inferior Vesical Artery, IVV: Inferior Vesical Vein, ADD: Artery to Ductus Deferens, OA: Obturator Artery, OV: Obturator Vein, ON: Obturator Nerve, EIA: External Iliac Artery, EIV: External Iliac Vein, IIA: Internal Iliac Artery, IIV: Internal Iliac Vein, OIM: Obturator internus muscle

Table 1 Bone thickness at 24 acetabular measurement points in 50 dry hemipelves (mm)

Location	Right (mm) mean ± SD	Left (mm) mean ± SD	Total (mm) mean ± SD
Diameter	52.3 ± 5.0	53.9 ± 5.0	53.1 ± 5.0
1 A	3.1 ± 1.0	3.6 ± 1.2	3.3 ± 1.0
1B	8.3 ± 2.3	9.1 ± 2.4	8.7 ± 2.3
2 A	3.4 ± 1.3	4.0 ± 1.4	3.7 ± 1.4
2B	24.2 ± 3.6	25.1 ± 3.7	24.7 ± 3.7
3 A	12.8 ± 1.8	13.4 ± 1.9	13.0 ± 1.9
3B	26.4 ± 4.8	28.3 ± 4.7	27.6 ± 4.8
4 A	13.2 ± 3.1	14.2 ± 3.2	13.8 ± 3.1
4B	14.0 ± 2.7	14.9 ± 2.6	14.4 ± 2.7
5 A	53.1 ± 4.2	54.0 ± 3.9	53.5 ± 4.0
5B	64.3 ± 6.2	66.3 ± 6.7	65.5 ± 6.5
6 A	50.3 ± 3.8	51.1 ± 4.1	50.7 ± 3.9
6B	67.3 ± 6.1	68.5 ± 6.2	67.9 ± 6.1
7 A	38.1 ± 6.2	40.2 ± 6.4	39.2 ± 6.3
7B	59.3 ± 6.6	60.9 ± 6.9	60.5 ± 6.8
8 A	68.2 ± 6.0	68.7 ± 6.6	68.5 ± 6.2
8B	19.5 ± 3.4	20.4 ± 3.4	20.0 ± 3.4
9 A	12.8 ± 2.1	13.4 ± 2.3	13.0 ± 2.4
9B	12.7 ± 2.6	13.3 ± 2.6	13.0 ± 2.6
10 A	5.0 ± 1.3	5.3 ± 1.4	5.2 ± 1.3
10B	12.1 ± 2.3	12.8 ± 2.3	12.5 ± 2.3
11 A	3.2 ± 0.8	3.5 ± 0.9	3.4 ± 0.9
11B	19.8 ± 3.2	21.0 ± 3.0	20.4 ± 3.1
12 A	3.0 ± 0.6	3.2 ± 0.5	3.1 ± 0.5
12B	3.4 ± 0.7	3.6 ± 0.7	3.5 ± 0.7

2.4 Statistical Analysis

Normality of continuous variables was assessed with the Shapiro-Wilk's test. Descriptive statistics are presented as mean±standard deviation or median (interquartile range), as appropriate. Right-left hemipelvis measurements were compared using an unpaired Student's t-test. Differences among sectors were evaluated using one-way ANOVA; when the omnibus test was not significant, no post-hoc analyses were performed. Intra- and inter-observer repeatability was expressed as ICC values with 95% confidence intervals. The average of the repeated measurements taken by two researchers was used as a single value in the analyses. A two-sided $p<0.05$ was considered statistically significant. Multiple-comparison correction was not applied, as analyses were hypothesis-driven and limited in number. Data processing was performed using PASW Statistics for Windows (v18.0) and Microsoft Excel for Mac (v16.96).

3 Results

We analyzed 50 dry hemipelves and 8 cadaveric acetabula overall.

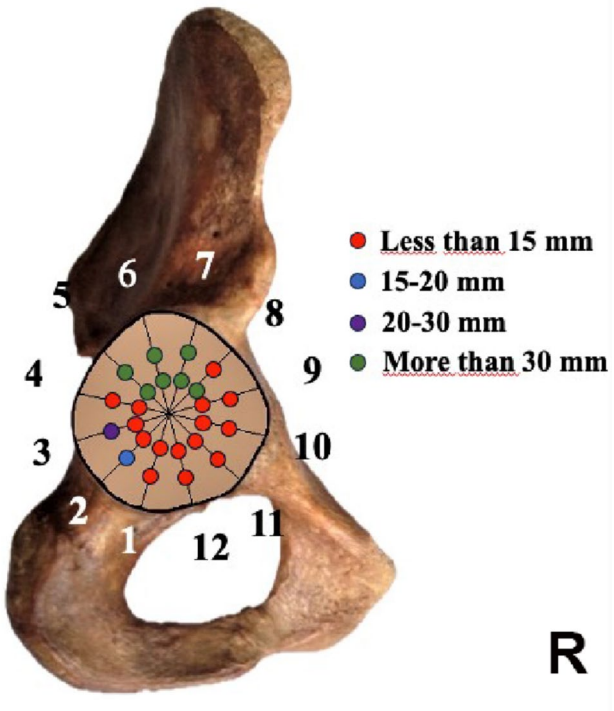


Fig. 5 Morphometric mapping of acetabular bone thickness. Values represent the minimum dry-bone thickness (mm) at central and peripheral points within each 30° sector. R: right side

3.1 Dry-Bone Thickness Measurements

The acetabular diameter was 53.1 ± 5.0 mm (range 45.3–64.0 mm). Right-left comparisons (unpaired t-test; $n=50$ total) showed no significant difference ($p>0.05$). Descriptively, points 5B, 6B, and 7B in the posterosuperior region showed the most favorable bone stock (for example, 6B 67.9 ± 6.1 mm), whereas 1 A, 2 A, and 12B represented higher-risk locations characterized by reduced bone thickness (typically ~ 3–4 mm). Descriptive statistics for thickness across all 24 points are shown in (Table 1) (mm). Minimum thickness values are illustrated in (Fig. 5). A one-way ANOVA found no significant differences in mean thickness among the 12 sectors ($p>0.05$). This ANOVA evaluated thickness only. The ICCs for acetabular diameter and bone thickness at each sector ranged from 0.887 to 0.993, indicating high intra- and inter-observer reliability.

Both intra- and inter-observer ICCs for acetabular diameter and bone thickness measurements showed high reliability (0.887–0.993). Bone thickness measurements in sectors designated for safe transacetabular screw placement exhibited very good reliability across all observers, further confirming these areas as dependable for clinical application.

3.2 Neurovascular Relationships in Cadavers ($n = 8$ Acetabula)

In cadaveric specimens, simulated screw paths demonstrated the following relationships with intrapelvic NV structures (Table 2):

- At the anterior inferior iliac spine (AIIS) level, the external iliac vein lay closer to the bone than the artery (mean ~ 6 mm vs. ~ 10 mm) (Table 2).
- At the acetabular dome (superior acetabular level), the vein again lay closer (mean ~ 4 mm vs. ~ 6 mm for the artery) (Table 2).
- Posteriorly near the greater sciatic notch, the superior/inferior gluteal arteries and the internal pudendal artery coursed near the inner acetabular surface (Table 2).
- Along the quadrilateral surface, the obturator NV bundle lay on the fascia of the obturator internus and was most exposed near the superolateral portion obturator foramen, i.e. at the obturator canal (Table 2).
- A prominent vesical venous plexus was commonly encountered adjacent to the medial pelvic wall, with marked anatomical variability (Table 2).

3.2.1 Combined Assessment of Simulated Screw Trajectories

Integrating dry-bone thickness with cadaveric NV clearance across the twelve radial trajectories, anterior paths typically offered limited bone stock and encountered a denser network of small-caliber vessels, whereas posterior and superolateral trajectories provided broader corridors with thicker bone and fewer critical NV structures. Trajectories traversing the external or internal iliac territories required precise angulation to avoid vascular injury. Based on this combined descriptive appraisal, points 5B-7B constituted the most favorable corridors for transacetabular screw placement, while 1 A, 2 A, and 12B were higher risk due to thin bone (often < 7 mm) and close NV adjacency (frequently ≤ 5 mm). Detailed NV distances (mm) and depth guidance for each radial projection are summarized in (Tables 2 and 3).

Table 2 Distances from the inner aspect of the acetabulum to adjacent neurovascular structures in cadaveric specimens ($n = 8$ acetabula, mm)

Anatomical Location (Level)	Structure(s) (Abbreviated)	Mean Distance (mm)	Range (mm)
Posterior border of acetabulum	SN	15	8–20
Greater sciatic notch	SGAV	4	2–8
	IGAV	9	7–12
	IPAV	5	3–7
Anterior inferior iliac spine	EIA	10	7–12
	EIV	6	4–9
Acetabular dome	EIA	6	4–8
	EIV	4	2–6
Quadrilateral surface	OAV, ON	—	1–4
Medial pelvic bone wall (near obturator foramen)	VVP	—	1–3

SN: Sciatic Nerve, SGAV: Superior Gluteal Artery and Veins, IGAV: Inferior Gluteal Artery and Veins, IPAV: Internal Pudendal Artery and Veins, EIA: External Iliac Artery, EIV: External Iliac Vein, OAV: Obturator Artery and Veins, ON: Obturator Nerve, VVP: Vesical Venous Plexus

4 Discussion

This study proposes a reproducible intra-articular landmark, the junction between the posterior articular surface of the lunate surface and the ischial ramus, to assist orientation for transacetabular screw placement in total hip arthroplasty. The landmark was readily identified on dry bones and in cadaveric specimens, and its intra-articular position suggests persistent visibility after acetabular preparation, enabling standardized mapping of safer versus higher-risk zones during cup fixation.

Conventional guidance often relies on external or side-dependent frameworks that can be unreliable intraoperatively. The quadrant method based on the anterior superior iliac spine depends on a non-visualized external landmark and can be difficult in obesity or altered pelvic morphology [11]. Alternative approaches have focused on intra-articular or tactile cues, e.g., using the acetabular fossa as a reference [15], the sciatic notch for tactile orientation [16], or "home-run" orientations developed for revision scenarios [20], yet these may lack a standardized entry point/angulation for primary THA.

Clock-face schemes [13, 14] are practical for clinical description but are limited by their side-dependency and failure to consider diameter variations. Consequently, they lack the reproducibility and standardized orientation required for patient-specific primary THA.

Our integrated dry-bone and cadaveric analysis identified the posterosuperior points (5B-7B) as the safest corridors for screw placement. In contrast, points 1 A, 2 A, and 12B were identified as high-risk zones due to insufficient bone thickness and their close proximity to neurovascular structures (Tables 1, 2 and 3). Cadaveric findings emphasized the vulnerability of anterior/inferior regions where the external iliac vessels and the obturator NV bundle traverse close to the inner pelvic wall, with the external iliac vein typically closer to bone than the artery at both the anterior inferior iliac spine and acetabular dome levels. These observations align with prior anatomical work highlighting NV risk in the anterior/inferior quadrants [8, 9, 21].

Table 3 Bone thickness and neurovascular proximity (mm) along simulated radial screw trajectories ($n=8$ cadavers)

Projection	Neurovascular Structures (Abbreviated)	Bone Thickness (mm)	Interpretive note (descriptive)
1 A	UA, SVA, SVV	<7	
1B	IVA, IVV, ADD	7–15	Nearest NV structures as listed; the outer segment was not directly abutted in most specimens—see Table 2 minimum distances
2 A	UA, SVA, SVV	≤7	
2B	IVV, ADD, IPAV, IGAV, SN	20–34	
3 A	UA, SVA, SVV	10–18	
3B	IVV, ADD, IPAV, IGAV, SN	>20	Clearance often accommodated screws≤25 mm; confirm with Table 2 minimum distances and intraoperative assessment.
4 A	UA, SVA, ADD	<10	
4B	IVV, SN	≤21	
5 A	UA	>45	
5B	IVV, SVV, ADD, SGAV	>43	Nearest NV structures as listed; the outer segment was not directly abutted in most specimens—see Table 2 minimum distances
6 A	UA, OAV, ON	>43	
6B	EIA, EIV, IIA, IIV, OAV, ON	>56	Clearance was generally favorable for longer screws in this sector; final screw length should be guided by Table 2 minimum distances and intraoperative assessment
7 A	UA, OAV, ON	>31	
7B	OAV, ON, EIA, EIV	>56	Clearance was generally favorable for longer screws; select length per Table 2 minimum distances and intraoperative findings
8 A	UA, OAV, ON	>56	
8B	EIA, EIV	15–27	Generally unfavorable due to proximity to EIA/EIV; consider alternative trajectory
9 A	UA, OAV, ON	≤18	
9B	None	9–18	No major NV structures were consistently encountered; however, variability precluded designating a consistent safe zone
10 A	UA, OAV, ON	<10	
10B	OAV, ON, DD	<19	
11 A	UA, OAV, ON	<6	
11B	DD, UA, OAV, ON	15–28	
12 A	UA	<5	
12B	None	<5	

UA: Umbilical Artery, SVA: Superior Vesical Artery, SVV: Superior Vesical Vein, IVA: Inferior Vesical Artery, IVV: Inferior Vesical Vein, ADD: Artery to Ductus Deferens, IPAV: Internal Pudendal Artery and Veins, IGAV: Inferior Gluteal Artery and Veins, SGAV: Superior Gluteal Artery and Veins, SN: Sciatic Nerve, OAV: Obturator Artery and Veins, ON: Obturator Nerve, EIA: External Iliac Artery, EIV: External Iliac Vein, IIA: Internal Iliac Artery, IIV: Internal Iliac Vein, DD: Ductus Deferens

An additional practical message is the often underestimated risk of venous bleeding. We frequently observed a variable venous plexus (vesical/pudendal branches) adjacent to the medial pelvic wall near the obturator foramen, which may bleed even in the absence of arterial or neural injury. This underscores the value of anatomy-based planning and cautious trajectory selection when engaging medial and inferior acetabular zones.

Taken together, using the lunate surface-ischial ramus junction as an intra-articular reference offers an anatomy-based alternative to quadrant or clock-face models and may help reduce NV injury risk in cementless acetabular fixation. These interpretations should be considered in light of sample characteristics (older male body donors), unknown demographics in the dry-bone collection, and the inherent differences between cadaveric and live surgical conditions, as detailed in Limitations. Prospective imaging-guided and intraoperative validation studies are warranted.

4.1 Clinical Implications

Identifying the junction between the posterior articular surface of the lunate surface and the ischial ramus (i.e., the acetabular fossa-ischial ramus junction) as an intra-articular landmark provides a practical, anatomy-based reference for orienting transacetabular screw placement in primary THA. In this study, the landmark was readily identified on cadaveric specimens and on dry bones. Its intra-articular position conceptually suggests persistent visibility after acetabular preparation; however, intraoperative accessibility and performance require clinical validation.

This landmark may be particularly useful when conventional external references are unreliable or visualization is constrained, such as minimally invasive approaches, patients with obesity, or selected revision scenarios where intra-articular orientation is challenging. By offering a reproducible point of reference, the technique may reduce reliance on fluoroscopy and improve workflow when navigation is unavailable; prospective studies are needed to determine any effects on surgical efficiency and the risk of NV complications.

Overall, these implications should be viewed as exploratory given that the current work is cadaveric/dry-bone and does not include clinical outcomes. Accordingly, the approach should be considered preliminary until validated by in vivo imaging-guided and intraoperative studies with clinical outcome measures.

4.2 Limitations

This study has limitations. The sample was limited older male body donors; demographics for the dry-bone collection were unavailable, limiting generalizability across sexes, ages, and populations. Applicability in dysplastic, advanced arthritic, or post-traumatic hips remains uncertain. Cadaveric conditions (formalin fixation, supine pelvic clamping) do not replicate in vivo tissue elasticity, vascular turgor, or bleeding. Non-perpendicular or variable trajectories were not assessed. Analyses were primarily descriptive and thickness-focused; sector "favorability" reflects the synthesis of thickness with cadaveric NV clearance rather than statistical superiority. Prospective in vivo and intraoperative validation studies with clinical outcomes are warranted.

4.3 Future Directions

Prospective in vivo and intraoperative studies should validate this landmark against current standards. Priority designs include randomized or controlled cohorts comparing the landmark-guided approach with quadrant/clock-face methods and, where available, navigation/robotics. Prespecified outcomes should include (primary) malposition and/or cortical breach, NV proximity/contacts, and intraoperative fluoroscopy time/image count; and (secondary) operative time, blood loss/transfusion, length of stay, complications, and early cup stability/surrogates.

Methodological questions merit dedicated evaluation: inter- and intra-observer agreement for localizing/marking the landmark (e.g., kappa/ICC), learning curve and time to identify, and post-reaming visibility documented by intraoperative photo/video or augmented reality (AR) tagging. Imaging correlation (3D CT or cone-beam CT) should quantify how often screws follow the intended corridor and the concordance with navigation/robotic guidance.

Finally, broader sampling is needed to establish generalizability: multicenter recruitment with a power analysis; inclusion of women, varied ages/ethnicities, and challenging anatomies (dysplasia, advanced OA, post-traumatic; selected revision THA as a predefined subgroup). Parallel CT-based morphometric work can refine corridor geometry by sex/size. Protocol preregistration and compliant data/image sharing will facilitate reproducibility and meta-analysis.

5 Conclusion

The junction between the posterior articular surface of the lunate surface and the ischial ramus, an intra-articular landmark readily identified on dry bones and in cadaveric specimens, provides a reproducible, anatomy-based reference for orienting transacetabular screw placement in cementless total hip arthroplasty. Our combined dry-bone and cadaveric mapping supports its anatomical consistency and highlights posterosuperior corridors as comparatively more favorable while underscoring anterior-inferior risk zones. These findings are descriptive and preclinical; prospective in vivo and intraoperative studies are required to validate accuracy, safety margins, and clinical utility. Integration with navigation/robotics workflows may further standardize application, but any effect on complications or efficiency remains to be determined.

Acknowledgements All the authors wish to extend their deepest gratitude to the body donors, whose generous contributions made this study possible.

Author Contributions BO: Idea/concept, Design, Data Collection and Processing, Analysis and Interpretation, Investigation, Methodology, Dissection, Resources. SK: Investigation, Methodology, Dissection, Resources, Supervision, Visualization, Writing, Editing. AU: Investigation, Methodology, Literature review, Writing, Editing. STK: Conceptualization, Data Curation, Investigation, Methodology, Resources, Supervision, Editing. NA: Methodology, Investigation, Editing, Control/supervision, Critical Review.

Funding Open access funding provided by the Scientific and Technological Research Council of Türkiye (TÜBİTAK).

Data Availability No datasets were generated or analysed during the current study.

Declarations

Conflict of interest The authors declare no competing interests. However, one of the authors (NA) is a member of the journal's Editorial Board but declares that he/she has not influenced the course of the anonymous and rigorous peer-review process.

Ethical Approval This study was conducted following approval from the Ankara University Faculty of Medicine Clinical Research Ethics Committee (Approval No: 46004091-302.14.06/E.3638) and conducted in accordance with the Declaration of Helsinki.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.

References

1. Abe EA, Parikh N, Nemirov DA, Tarabichi S, Sherman MB, Courtney PM, et al. Health care utilization and costs in the year before and after total hip arthroplasty. J Arthroplasty. 2025. https://doi.org/10.1016/j.arth.2025.06.059.
2. Mohabey A, Warjukar P. Relating total hip replacement and acetabular cup positioning with outcome: A systematic review. Bioinformation. 2025;21(2):145–54.
3. Tabata T, Kaku N, Hara K, Tsumura H. Initial stability of cementless acetabular cups: Press-fit and screw fixation interaction: An in vitro biomechanical study. Eur J Orthop Surg Traumatol. 2015;25(3):497–502.
4. Lau LCM, Wong KY, Hu H, Cheung MH, Ng FY, Fu H, et al. Cementless acetabular component without screw holes with immediate full weightbearing. Bone Joint Open. 2025;6(5 Suppl A):14–21.
5. Sheridan GA, Lowe LYH, Hughes AJ, Courtney PM, Sidhu A, MacDonell T, et al. The selective use of acetabular screws in routine primary total hip arthroplasty is noninferior to habitual screw use. J Arthroplasty. 2025;40(8 Suppl 1):S186–9.
6. Alshameeri Z, Bajekal R, Varty K, Khanduja V. Iatrogenic vascular injuries during arthroplasty of the hip. Bone Joint J. 2015;97–B(11):1447–55.
7. Kirkpatrick JS, Callaghan JJ, Vandemark RM, Goldner RD. The relationship of the intrapelvic vasculature to the acetabulum: Implications in screw-fixation acetabular components. Clin Orthop Relat Res. 1990;258:183–90.
8. Ohashi H, Kikuchi S, Aota S, Hakozaki M, Konno S. Surgical anatomy of the pelvic vasculature with particular reference to acetabular screw fixation in cementless total hip arthroplasty in an Asian population: A cadaveric study. J Orthop Surg. 2017;25(1):1–6.
9. Park JY, Kwon HM, Lee WS, Yang IH, Park KK. Anthropometric measurement about the safe zone for transacetabular screw placement in total hip arthroplasty in Asian middle-aged women: In vivo three-dimensional model analysis. J Arthroplasty. 2021;36(2):744–51.
10. Lu Q, Zhou R, Gao S, Liang A, Yang M, Yang H. CT-scan based anatomical study as a guidance for infra-acetabular screw placement. BMC Musculoskelet Disord. 2021;22:576.
11. Wasielewski RC, Cooperstein LA, Kruger MP, Rubash HE. Acetabular anatomy and the transacetabular fixation of screws in total hip arthroplasty. J Bone Joint Surg Am. 1990;72(4):501–8.
12. Stefanini N, Pederiva D, Brunello M, Geraci G, Pilla F, Capozzi E, et al. Acetabular screws placement in primary and revision total hip arthroplasty: A narrative review. Arch Orthop Trauma Surg. 2025;145(1):354.
13. Liu Q, Zhou YX, Xu HJ, Tang J, Guo SJ, Tang QH. Safe zone for transacetabular screw fixation in prosthetic acetabular reconstruction of high developmental dysplasia of the hip. J Bone Joint Surg Am. 2009;91(12):2880–5.
14. Brodt S, Boersch V, Strube P, Wassilew G, Matziolis G. Defining the canal for ischial and pubic screws in cup revision surgery. Int Orthop. 2022;46(11):2547–52.
15. Ihn HE, Chung BC, Lovro L, Chen XT, Tucker D, White E, et al. Identifying a reliable intra-articular landmark to avoid vascular injury during transacetabular screw fixation: A 3D computed tomography study. J Am Acad Orthop Surg. 2025;33(3):e172–80.
16. van der Merwe JF, Erasmus LJ, van der Merwe W, Ellis JA. Obtaining optimum screw placement for revision acetabular prostheses using the sciatic notch as reference. Transl Res Anat. 2021;24:100133.
17. Ni S, Luo P, Guo L, Jiang T. Are additional screws required for press-fit fixation of cementless acetabular cups? A systematic review and meta-analysis. J Orthop Traumatol. 2022;23:9.
18. Stroud J, Yan ET, Anthony J, Walker K, Goh CH. Optimizing screw fixation in total hip arthroplasty: A deep learning and finite element analysis approach. Appl Sci. 2025;15(7):3722.
19. Simon S, Gobi H, Mitterer JA, Frank BJH, Huber S, Aichmair A, et al. Rate and patient-specific risk factors for periprosthetic acetabular fractures during primary total hip arthroplasty using a press-fit cup. J Arthroplasty. 2025. https://doi.org/10.1016/j.arth.2025.05.075.
20. Wessling M, Gebert C, Marei M, Dudda M, Streitbuerger A, Aach M, et al. Acetabular home-run screw guidance for transiliac fixation in cup revision arthroplasty. J Clin Med 2025;14(3).
21. Feugier P, Fessy MH, Béjui J, Bouchet A. Acetabular anatomy and the relationship with pelvic vascular structures: Implications in hip surgery. Surg Radiol Anat. 1997;19(2):85–90.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.