INSIGHTS-JOURNAL OF
HEALTH AND REHABILITATION

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

ASSESSMENT OF PRE-OPERATIVE PREDICTORS FOR FEMORAL SHORTENING IN DEVELOPMENTAL DYSPLASIA OF HIP

Original Research

Zeeshan Khan[1], Abbas Ali[2], Imtiaz ur Rehman[1]*, Wajid Ullah[1], Muhammad Zeb[1], Waqar Ali[1]
[1]PGR FCPS, Department of Orthopaedic Surgery, Khyber Teaching Hospital (KTH), Peshawar, Pakistan.
[2]Assistant Professor Orthopaedic, Department of Orthopaedic Surgery, Khyber Teaching Hospital (KTH), Peshawar, Pakistan.
Corresponding Author: Imtiaz ur Rehman, PGR FCPS, Department of Orthopaedic Surgery, Khyber Teaching Hospital (KTH), Peshawar, Pakistan, imtiazkmc164@gmail.com
Acknowledgement: The authors are grateful to the orthopedic team of Khyber Teaching Hospital for their support.

Conflict of Interest: None
Grant Support & Financial Support: None

ABSTRACT

Background: Femoral shortening is a critical adjunct during open reduction for developmental dysplasia of the hip (DDH), especially in cases presenting late or with severe dislocation. It reduces soft tissue tension and minimizes complications like avascular necrosis and redislocation. Despite its importance, limited data exist regarding preoperative predictors of its necessity, particularly in local clinical settings.

Objective: To determine the preoperative factors associated with the need for femoral shortening during surgical management of DDH.

Methods: A cross-sectional study was conducted at the Department of Orthopaedic Surgery, Khyber Teaching Hospital, Peshawar. A total of 169 children aged 1–10 years, diagnosed with IHDI grade 3 or 4 DDH and scheduled for open reduction, were enrolled through non-probability consecutive sampling. Data on demographics, clinical history, and radiological findings were collected. The primary outcome was whether femoral shortening was performed, assessed intraoperatively. Statistical analysis was performed using SPSS v25, with chi-square tests and binary logistic regression applied to identify significant predictive factors ($p \leq 0.05$).

Results: Femoral shortening was performed in 89 patients (52.7%). Significant predictors included age >5 years (76.4%), female gender (66.2%), breech delivery (64.3%), positive family history of DDH (61.8%), and IHDI grade 4 (72.5%). Each of these variables showed a strong association with the likelihood of undergoing femoral shortening during surgery.

Conclusion: Older age, female gender, breech presentation, familial predisposition, and higher DDH grade are strong preoperative indicators for femoral shortening. Early identification of these factors allows for better surgical planning and improved parental counseling.

Keywords: Breech Presentation, Developmental Dysplasia of Hip, Femoral Osteotomy, Femoral Shortening, Orthopedic Surgery, Pediatric Orthopedics, Predictive Factors.

INTRODUCTION

Developmental dysplasia of the hip (DDH) is a condition with a broad spectrum of anatomical abnormalities, ranging from subtle acetabular dysplasia to complete dislocation of the femoral head. Surgical management is often required in children who fail to respond to conservative treatment, with open reduction being a mainstay approach, particularly in late-presenting cases. One of the pivotal challenges in achieving a successful reduction is addressing soft tissue contracture, which can hinder concentric reduction and increase the risk of complications such as avascular necrosis, re-dislocation, and post-operative stiffness due to excessive tension across the hip joint (1,2). To mitigate these risks, femoral shortening osteotomy is frequently employed. This additional procedure facilitates reduction by relieving undue pressure on the femoral head and allowing for a tension-free reduction. Subtrochanteric osteotomy is the preferred technique over intertrochanteric osteotomy for femoral shortening in most clinical settings (3,4). A study proposed a practical approach to estimate the required shortening, typically around 2 to 3 cm, by measuring the overlap between the proximal and distal femur segments, and they utilized a four-hole plate for fixation without rotational change (5). A cohort study of 20 hips, reported no shortening beyond 2 cm, with only two complications believed to stem from overcorrection of anteversion (6). Similarly, a study observed no significant leg length discrepancies in 33 hips post-shortening, further supporting the efficacy of this surgical adjunct (7). Contemporary understanding of DDH anatomy has shifted surgical trends away from varus-producing osteotomies due to the potential for persistent femoral neck varus (8), and while derotation osteotomies are sometimes considered in severe anteversion cases, they remain used cautiously (9).

Femoral shortening is not uniformly required for all DDH cases and is instead considered based on specific intraoperative and preoperative factors. According to a study, age and femoral head displacement significantly influence the decision to perform shortening (10,11). A study involving 119 patients undergoing open reduction revealed a high prevalence of femoral shortening among older children and those with higher DDH grades, with the majority being females and having grade 4 DDH based on the International Hip Dysplasia Institute (IHDI) classification (12). Despite the clinical importance of femoral shortening, literature remains limited on predictive factors that may aid in preoperative planning and parental counseling. In particular, there is a notable gap in data from local contexts, limiting the ability of clinicians to anticipate the need for femoral shortening before surgery. Addressing this gap is essential for optimizing surgical outcomes and improving patient-family communication. Preoperative identification of predictive factors such as patient age, gender, family history, breech presentation, and DDH severity may support more informed surgical planning. Furthermore, a proactive approach to recognizing these predictors could potentially reduce operative time, enhance surgical preparedness, and minimize post-operative complications. The objective of this study is therefore to determine the pre-operative factors associated with the need for femoral shortening in patients undergoing surgical management for developmental dysplasia of the hip.

METHODS

This cross-sectional study was conducted in the Department of Orthopaedic Surgery at Khyber Teaching Hospital, Peshawar, over a period of six months following the approval of the research synopsis by the Institutional Review Board (IRB). Ethical approval was obtained prior to study commencement and written informed consent was obtained from the parents or legal guardians of all participating children after detailed explanation of the study's purpose, risks, and benefits. The study population consisted of pediatric patients aged between 1 and 10 years, of either gender, diagnosed with developmental dysplasia of the hip (DDH) classified as grade 3 or 4 according to the International Hip Dysplasia Institute (IHDI) classification system (13). Only patients scheduled for open reduction through an anterior approach were included. Exclusion criteria comprised non-idiopathic dislocations secondary to systemic or local diseases, prior surgery on the same hip joint, syndromic conditions, Pott's disease, and neuromuscular disorders. The sample size was calculated using the World Health Organization formula, assuming an anticipated proportion of 56% of children over 5 years undergoing femoral shortening (1), a margin of error of 7.5%, and a 95% confidence level, yielding a sample size of 169. A non-probability consecutive sampling technique was employed to recruit participants. Baseline demographic data including age, gender, body mass index (BMI), residence, maternal education, paternal occupation, and socioeconomic status were recorded. Clinical details such as history of breech delivery, family history of DDH in first-degree relatives, and IHDI grade were collected according to operational definitions. The primary outcome of interest was the need for femoral shortening during open reduction surgery, noted intraoperatively by the consultant

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

orthopedic surgeon. The surgical decision to perform femoral shortening was based on either the inability to reduce the hip or the presence of excessive tension during reduction following capsulotomy, necessitating a tension-free construct.

Standard surgical protocols were followed. After anterior capsulotomy, adductor longus, rectus femoris, and iliopsoas tenotomies were routinely performed. Femoral shortening was executed via a separate lateral incision with two transverse subtrochanteric osteotomies, followed by fixation using a four-hole plate and postoperative immobilization in a hip spica cast. External rotation correction of the distal fragment was performed selectively for patients with significant femoral anteversion. A pelvic osteotomy was performed subsequently, followed by capsular repair (14,15). In cases of bilateral dislocation, the contralateral hip was scheduled for surgery on a different date. Preoperative traction was not utilized. Data regarding the performance of femoral shortening and associated predictors were documented on a predesigned proforma by the primary investigator. Data analysis was performed using IBM SPSS version 25. Normality of continuous variables such as age and BMI was assessed using the Shapiro-Wilk test. Means and standard deviations or medians with interquartile ranges were reported accordingly. Categorical variables, including gender, residence, maternal education, paternal profession, socioeconomic status, family history of DDH, breech delivery, and DDH grade, were summarized as frequencies and percentages. Associations between potential predictors and the performance of femoral shortening were evaluated using chi-square tests or Fisher's exact test where appropriate, with a significance level set at 0.05. A binary logistic regression model was employed to estimate the probability of femoral shortening based on independent variables, including age over five years, female gender, breech delivery, first-degree relative with DDH, and IHDI grade 4. Odds ratios with 95% confidence intervals were calculated, with statistical significance determined by confidence intervals excluding value 1. Stratification was conducted for age, gender, laterality, and BMI to control for confounding, followed by post-stratification chi-square or Fisher exact tests.

RESULTS

Out of a total of 169 patients included in the study, the mean age was 5.4 ± 2.2 years, with ages ranging from 1 to 10 years. The majority of the participants were female (62.1%, n=105), while males constituted 37.9% (n=64). The average BMI was 17.3 ± 2.5 kg/m². In terms of socioeconomic status, 36.7% (n=62) of children belonged to the lower class, 47.9% (n=81) to the middle class, and 15.4% (n=26) to the upper class. Most of the parents were employed (85.2%, n=144), while 14.8% (n=25) were unemployed. A rural background was more common (58.0%, n=98), and 60.4% (n=102) of the parents were educated, while 39.6% (n=67) were uneducated. Regarding the laterality of the hip joint affected, the right hip was involved in 53.3% (n=90) and the left in 46.7% (n=79). Most patients (66.3%, n=112) were diagnosed with IDHI grade 4 DDH, while 33.7% (n=57) had grade 3. Femoral shortening was performed in 52.7% of cases (n=89), while 47.3% (n=80) underwent open reduction without the need for femoral shortening. The frequency of femoral shortening was significantly associated with age, gender, DDH grade, breech delivery, and family history. Among patients aged more than five years, 76.4% required femoral shortening compared to only 23.6% in those aged five years or younger. Similarly, 66.2% of females underwent femoral shortening versus 33.8% who did not. Children with a first-degree relative (FDR) having DDH showed a 61.8% rate of femoral shortening, whereas 38.2% without such family history required the procedure. In patients with IDHI grade 4, 72.5% underwent femoral shortening, significantly higher than those with grade 3. Breech delivery was also a notable factor; 64.3% of breech-born children required shortening, while 35.7% did not. These findings indicate that the probability of requiring femoral shortening is increased in the presence of certain preoperative factors such as older age, female gender, breech birth, family history of DDH, and higher DDH grade. Further statistical associations and predictive models were calculated in the analysis phase to validate these findings.

Table 1: Demographic Characteristics

Variable		Distribution
Age (Mean ± SD)		5.4 ± 2.2 years
Gender	Male	64 (37.9%)
	Female	105 (62.1%)
BMI (Mean ± SD)		17.3 ± 2.5 kg/m²
Socioeconomic Status	Lower	62 (36.7%)
	Middle	81 (47.9%)
	Upper	26 (15.4%)
Parental Occupation	Employed	144 (85.2%)

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

Variable		Distribution
	Unemployed	25 (14.8%)
Residence	Rural	98 (58.0%)
	Urban	71 (42.0%)
Parental Education	Educated	102 (60.4%)
	Uneducated	67 (39.6%)

Table 2: Femoral Shortening Outcome

Femoral Shortening	Frequency (n)	Percentage (%)
Yes	89	52.7%
No	80	47.3%

Table 3: Predictive Factors of Femoral Shortening

Predictive Factor	Yes, with FS (%)	No, with FS (%)
Age >5 years	76.4%	23.6%
Female Gender	66.2%	33.8%
FDR with DDH	61.8%	38.2%
IDHI Grade 4	72.5%	27.5%
Breech Delivery	64.3%	35.7%

Table 4: IDHI Grade and Laterality Distribution

Variable	Frequency (n)	Percentage (%)
IDHI Grade 3	57	33.7%
IDHI Grade 4	112	66.3%
Right Hip	90	53.3%
Left Hip	79	46.7%

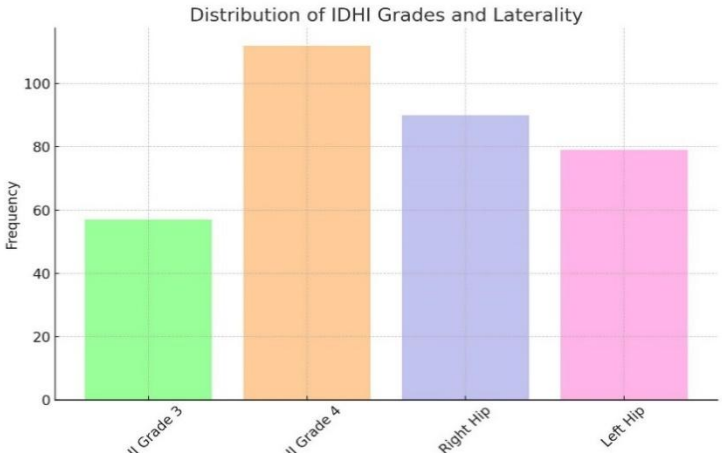

Figure 2 Distribution of IDHI Grades and Laterality

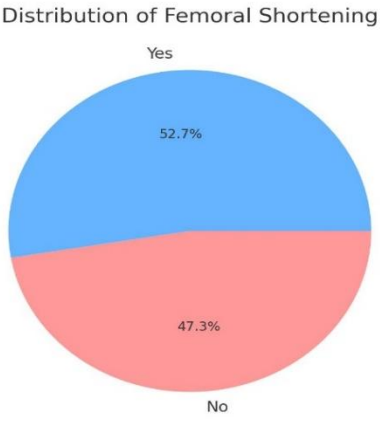

Figure 1 Distribution of Femoral Shortening

DISCUSSION

The present study evaluated the preoperative predictors associated with the need for femoral shortening during open reduction for developmental dysplasia of the hip (DDH). The findings revealed a significant association of femoral shortening with age over five years, female gender, breech presentation, positive family history of DDH, and higher IHDI grades. These results contribute to the

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

growing body of literature emphasizing patient-specific risk profiling in surgical planning for DDH. Femoral shortening remains a crucial step in achieving a tension-free reduction during DDH surgery, particularly in older children and those with high-grade dislocations. Our finding that age above five years is strongly associated with the need for femoral shortening aligns with existing literature. A recent study demonstrated that increasing age was a key risk factor for femoral overgrowth and limb length discrepancy following femoral shortening osteotomy, underscoring the anatomical and biomechanical challenges of late presentations (16). Similarly, another study emphasized that femoral shortening may not be routinely needed in children aged 2–3 years with Tönnis grade III DDH, further supporting age-based surgical decision-making (17). The predominance of femoral shortening among females in our cohort is in line with the known epidemiological distribution of DDH, where female infants are more frequently affected due to maternal hormonal influences and ligamentous laxity. A study confirmed that in Crowe IV dysplastic hips, female patients undergoing femoral shortening osteotomy with total hip arthroplasty achieved good outcomes with long-term stability, reflecting the procedural need and its efficacy in this demographic (18). Another noteworthy observation was the high frequency of femoral shortening among patients with breech deliveries. Breech presentation has long been established as a significant risk factor for DDH, contributing to the mechanical displacement of the femoral head and a more severe pathological anatomy. While not extensively studied in the context of femoral shortening itself, the link between breech presentation and DDH severity has been reported in several works found that anatomical parameters such as greater operative leg length discrepancy and altered acetabular positioning were significant predictors for shortening osteotomy (19-21).

IDHI grade 4 severity was strongly correlated with the need for shortening in our analysis, reaffirming the principle that greater dislocation severity necessitates additional femoral shortening to achieve stable reduction without compromising perfusion to the femoral head. Similar conclusions were drawn by a study which demonstrated reduced rates of avascular necrosis in Tönnis type IV hips managed with combined open reduction and femoral shortening osteotomy (22,23). The study's strengths include a well-defined cohort, strict adherence to operational definitions, and structured data collection, enhancing internal validity. However, some limitations merit acknowledgment. The single-center nature and non-randomized design limit generalizability. Additionally, variables such as degree of soft tissue tightness and intraoperative acetabular morphology, which may influence shortening decisions, were not included. Furthermore, potential confounding factors like socioeconomic and nutritional status, although recorded, were not analyzed in the final model. Future research should aim at multicentric prospective trials incorporating advanced imaging and functional outcome scores. Incorporating 3D morphological modeling as shown by a study can refine preoperative prediction models for femoral shortening and assist in surgical planning (24). Additionally, the development of scoring systems integrating anatomical, demographic, and radiographic data may improve prediction accuracy and allow more personalized treatment. In conclusion, the study reaffirms that older age, female gender, breech presentation, positive family history, and severe DDH grades significantly predict the need for femoral shortening. Recognizing these factors preoperatively can aid in surgical preparedness, reduce intraoperative decision uncertainty, and enhance patient-family counseling.

CONCLUSION

This study identified age over five years, female gender, breech presentation, positive family history, and IDHI grade 4 as significant preoperative predictors for femoral shortening during open reduction in developmental dysplasia of the hip. Recognizing these factors in clinical practice can enhance surgical planning, reduce intraoperative uncertainty, and support informed counseling for caregivers, ultimately improving patient outcomes.

AUTHOR CONTRIBUTION

Author	Contribution
Zeeshan Khan	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Abbas Ali	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Imtiaz ur Rehman*	Substantial Contribution to acquisition and interpretation of Data

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

Author	Contribution
	Has given Final Approval of the version to be published
Wajid Ullah	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Zeb	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Waqar Ali	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

REFERENCES

1. Miyazaki T, Shimizu T, Ohura H, Katayama N, Iwasaki N, Takahashi D. Total hip arthroplasty with femoral shortening osteotomy using polished cemented stem vs. modular cementless stem in patients with Crowe type IV developmental dysplasia of the hip. Arch Orthop Trauma Surg. 2023;143(6):3487-93.
2. Ibrahim FMF, Gameel S. Total cementless unconstrained hip arthroplasty in Crowe type IV hip dysplasia with subtrochentric derotation osteotomy. Acta Orthop Belg. 2022;88(3):517-24.
3. Tao K, Wang SC, Ma XY, Shao L, Di ZL, Huang ZY. Three-dimensional femur morphology analysis for the optimal location of subtrochanteric osteotomy with an implanted Wagner cone stem in total hip arthroplasty for Crowe type IV developmental dysplasia of the hip. J Orthop Surg Res. 2023;18(1):410.
4. Talwar J, Agarwal S, Agarwal S, Krishna LG, Rustagi A. Step-Cut Subtrochanteric Osteotomy Combined with Total Hip Arthroplasty for Neglected Traumatic Hip Dislocations. Clin Orthop Surg. 2022;14(2):205-12.
5. Davulcu CD, Ozsahin MK, Kayaalp ME, Celayir A, Akbaba D, Unlu MC. Rectangular femoral stems can successfully accommodate the medullary canal in patients with severe hip dysplasia operated on with total hip arthroplasty and a shortening osteotomy: A morphometric study. Acta Orthop Belg. 2024;90(4):581-7.
6. Köroğlu C, Özdemir E, Çolak M, Şensöz E, Öztuna FV. Open reduction and Salter innominate osteotomy combined with femoral osteotomy in the treatment of developmental dysplasia of the hip: Comparison of results before and after the age of 4 years. Acta Orthop Traumatol Turc. 2021;55(1):28-32.
7. Sun J, Cui Y, Qu J, Lian F. Mathematical calculation of the difference in shortening length after two types of proximal femoral varus and an investigation of their applicable conditions: an own-pair design. J Orthop Surg Res. 2022;17(1):563.
8. Sun C, Zhang Y, Li LT, Ding H, Guo T, Zhao JN. Long-Term Outcomes of Total Hip Arthroplasty With Transverse Subtrochanteric Shortening Osteotomy and Modular Stem in Crowe IV Developmental Dysplasia. J Arthroplasty. 2021;36(2):630-5.
9. Du YQ, Guo LF, Sun JY, Shen JM, Zhang BH, Jin ZG, et al. The Influence of Femoral Proximal Medullary Morphology on Subtrochanteric Osteotomy in Total Hip Arthroplasty for Unilateral High Dislocated Hips. Orthop Surg. 2021;13(6):1787-92.
10. Rego P, Mascarenhas V, Mafra I, Oliveira F, Pinto P, Ganz R. Femoral neck osteotomy in skeletally mature patients: surgical technique and midterm results. Int Orthop. 2021;45(1):83-94.
11. Li Y, Zhang Z, Ren N, Cheng H, Luo D, Zhang H. [Effects of femoral offset and mechanical axis of the lower extremity on hip after osteotomy for adult developmental dysplasia of the hip]. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi. 2021;35(12):1549-54.
12. Cao J, Gao C, Sun JH, Zheng HJ, Zhu HY, Zhong ZP, et al. Effect of 3D Printing Technology in Proximal Femoral Osteotomy in Children with Developmental Dysplasia of the Hip. Dis Markers. 2022;2022:1291996.
13. Bourantas CA, Behrman EC, Shepherd MC, Lohse KR, Clohisy JC, Harris MD. Dynamic femoral head coverage following periacetabular osteotomy for developmental dysplasia of the hip. Clin Biomech (Bristol). 2025;124:106471.
14. Karaismailoglu B, Karaismailoglu TN. Comparison of Trochanteric Slide and Subtrochanteric Shortening Osteotomy in the Treatment of Severe Hip Dysplasia: Mid-Term Clinical Outcomes of Cementless Total Hip Arthroplasty. J Arthroplasty. 2020;35(9):2529-36.
15. Bulut M, Azboy I, Ozkul E, Karakurt L. Comparison of Iliac and Femoral Autograft Practices in Pemberton Pelvic Osteotomy. J Pediatr Orthop. 2021;41(1):46-50.

16. Mo TT, Zhu YS, Zhang JN, Zhang WK, Jiang C. The clinical effect of trochanteric slide osteotomy combined with a cementless femoral conical stem in total hip replacement for the treatment of Crowe type IV developmental dysplasia of the hip. Technol Health Care. 2023;31(2):553-63.
17. Kayaalp ME, Can A, Erdogan F, Ozsahin MK, Aydingoz O, Kaynak G. Clinical and Radiological Results of Crowe Type 3 or 4 Dysplasia Patients Operated on With Total Hip Arthroplasty Using a Cementless Rectangular Femoral Component Without Fixating or Grafting the Transverse Osteotomy Site. J Arthroplasty. 2020;35(9):2537-42.
18. Zha GC, Wang Y, Zhang K, Guo ZT, Luo JW, Guo KJ, et al. The Clinical and Radiological Outcomes of Subtrochanteric Osteotomy in Crowe Type IV Hip Dysplasia: A Comparison of Three Different Stem Designs. J Am Acad Orthop Surg. 2022;30(12):e867-e77.
19. Lyu X, Fu G, Feng C, Yang J, Wang Y, Zhu Z. Clinical and radiological outcomes of combined acetabuloplasty with acetabular redirectional osteotomy and femoral shortening for children older than 9 years of age with developmental dysplasia of the hip: a retrospective case series. J Pediatr Orthop B. 2020;29(5):417-23.
20. Li F, Wu Y, Song Z, Tadum Arthur Vithran D, Li X, Fang K, et al. Characteristics of surface electromyogram signals after Pemberton pelvic osteotomy combined with femoral osteotomy in children with unilateral developmental dysplasia of the hip. Medicine (Baltimore). 2022;101(28):e29794.
21. Tikhilov RM, Dzhavadov AA, Ziganshin DR, Zakhmatov NS, Alekberov RR, Shubnyakov, II. Cementless Total Hip Arthroplasty With Paavilainen Femoral Shortening Osteotomy Can Provide Good Results at 10 Years in Patients Who Have Crowe IV Developmental Dysplasia of the Hip. J Arthroplasty. 2024;39(9):2316-22.
22. Barbaret A, Laisne P, Flecher X, Jacquet C, Argenson JN. Can customised total hip arthroplasty without femoral shortening osteotomy improve functional outcome and long-term stem survivorship in developmental dysplasia of the hip? Hip Int. 2025;35(3):308-14.
23. Hu Y, Zhang J, Sun Z, Yu D, Li H, Zhu Z, et al. Application of a novel osteotomy instrumentation as a substitute tool in total hip arthroplasty. BMC Musculoskelet Disord. 2022;23(1):437.
24. Uemura K, Hiraiwa T, Okamoto M, Tokunaga K, Anderson AE. The anterior center edge angle has limited ability to predict three-dimensional coverage of the femoral head in patients with developmental dysplasia of the hip undergoing curved periacetabular osteotomy. Arch Orthop Trauma Surg. 2023;143(3):1323-30.

