Risk Factors of Femoral Fractures in Lateral Decubitus Direct Anterior Approach Total Hip Arthroplasty Using Conventional Stem: A Retrospective Analysis

Guanjun Sun (✉ Hxsungj@163.com)  
Suining Central Hospital  https://orcid.org/0000-0002-8938-5108

Yi Yin  
Suining Central Hospital

Yongjie Ye  
Suining Central Hospital

Qingshan Li  
Suining Central Hospital

Research article

Keywords: Arthroplasty, Replacement, Hip, Direct anterior approach, Lateral decubitus position, Femur, Fracture

DOI: https://doi.org/10.21203/rs.3.rs-91960/v1

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

Objective: In order to provide guideline to operation and reduce the incidence of fractures, this study analyze the relationship between femoral fractures and related factors in direct anterior approach (DAA) total hip arthroplasty (THA) in lateral decubitus position.

Method: A consecutive retrospective series of 273 THA by DAA in lateral decubitus position were analyzed. The surgery were performed by the same surgeon with conventional operation bed and femoral stem. The correlations between incidence of fractures with gender, age, body mass index (BMI), height, osteoporosis, anterior superior iliac spine-greater trochanter distance (ASIS-GTD), and hip-joint diseases were analyzed by univariate analysis and logistic regression analysis.

Results: Among all hip arthroplasty, 34 cases had femoral fractures, including 29 greater trochanter fractures, 4 proximal femoral splits and 1 femoral perforation. The incidence of fractures was 13.03%. Univariate analysis: the discrepancies in incidence of fractures among genders, BMIs and age were not significant different; osteoporosis caused an increase of fractures; the incidence of fractures declined as height, ASIS-GTD increased; The incidence of femoral neck fracture and osteonecrosis of femoral head was lower than others. Logistic regression results: there was a significant correlation between osteoporosis, ASIS-GTD and fractures. Patients with osteoporosis had a high possibility of fractures (OR=2.353); the possibility of fractures decreased with an upward ASIS-GTD(OR=0.939).

Conclusion: The lateral decubitus DAA THA can be successfully performed using conventional operation bed and stem, which saved medical resources effectively. Osteoporosis and ASIS-GTD were independent risk factors for femoral fractures; Short stature, inflammatory arthroses were relatively risk factors.

Background

THA is one of the most effective operations for the treatment of severe hip disease, and its efficacy has been unanimously recognized by physicians and patients. THA can effectively alleviate arthralgia, restore joint function, and correct articular malformation[1]. There are multiple approaches to perform THA, such as posterior approach, direct lateral approach, and DAA, etc. Surgeons may choose a specific approach according to their experiences[2]. With the development of enhanced recovery after surgery (ERAS) in recent years[3,4], DAA has gained more and more attentions, and its utilization in clinical was increased. DAA is reported to perform to the anterior hip joint through the intervals between tensor fascia lata and sartorius muscles, rectus femoris muscles[5]. DAA utilizes the neuromuscular interval, has the advantages of little intraoperative bleeding, short invasive incision, and improved recovery time[6]. However, the operation space of DAA was restricted by the anterior superior iliac spine (ASIS) and greater trochanter (GT), especially on the femur side. In patients with short stature and short femoral neck, the femur operation was even difficult, and the risk of femoral fractures was higher than the posterior approach[7]. The reliability of lateral DAA THA need to be further verified also[8].

In the United States, Europe and many hospital in China, DAA THA was mainly performed in supine position with short femoral stem, which required special operation bed and high cost[9,10]. There was not special
operation bed in our Hospital. All operations were performed by conventional operation bed and conventional femoral stem in primary THA, which had the benefits of low cost and equipment, convenient to operation[11-13]. The postoperative outcome was satisfactory in DAA THA, but the femoral fracture rate was higher than posterior approach. In this study, we performed a retrospective analysis of 261 patients (273 hips) treated by the same surgeon in lateral decubitus position from January 2018 to January 2020. In order to analyze the safety of this surgical approach, and predict the risk of femoral fractures, we analyzed the correlation between the incidence of fractures and all risk factors, like gender, age, BMI, height, osteoporosis, ASIS-GTD and hip diseases. This study would also give out the guideline of preoperative planning to reduce the incidence of fractures.

1 Information And Methods

1.1 General information

The consecutive analysis contained a total of 261 patients (273 hips), from January 2018 to January 2020 in our Hospital. All the patient had DAA THA by the same surgeon, who is experienced in this surgery. There were 132 male patients and 129 female patients, aged 33-89 years, with BMI of 14.44-31.63 kg/m². There were 88 patients reported with osteoporosis, which was measured by dual energy X-ray absorptiometry(DXA), diagnostic criteria: T≤-2.5 SD.(Table 1). The ASIS-GTD is the distance between the ASIS and GT, which can reflect the greater trochanter relative to the anterior superior iliac spine to the distal, lateral situation. It was measured on the supine pelvic X-rays using the PACS radiation software (Figure a). This study has been approved by the ethics committee of the authors hospital.

Preoperative diagnosis included: osteonecrosis of femoral head (ONFH, FicatⅢⅣ), osteoarthritis(OA), developmental dysplasia of hip (DDH, CroweⅠⅡⅢ), femoral neck fracture (FNF), osteonecrosis of femoral head after cannulated screw fixation of femoral neck fractures (internal fixation in body 12 patients), coxa plana, ankylosing spondylitis, and rheumatoid arthritis(RA). The femoral stem were Link L.C.U and Zimmer M/L, proximal 1/3 coated. Exclusion criteria: 1. Systemic or local active infection; 2. Severe malformation of acetabulum or femur; 3. Hip ankylosis.

1.2 Preoperative preparation

Before surgery, patients received standard pelvic anterior-posterior, ipsilateral femoral neck oblique radiography, and CT of hip joint. Femoral bone marrow cavity diameter, acetabular size, femoral neck osteotomy position and the height of hip rotation center relative to the greater trochanter of the femur were measured. Patients received regular infusion of antibiotics and tranexamic acid half an hour before operation.

1.3 Operation procedure
The patient contralateral on a regular operation table to ensure that the horizontal axis of the pelvis is perpendicular to the table (Shown in figure b). An oblique incision is made originating 2cm inferior and lateral to the ASIS inclined to the fibular head, in a length of 8cm. Divide the tensor fascia lata and sartorius muscle then into the Heuter interval. The ascending branch of the lateral circumflex femoral artery is cauterized and severed. A retractor is placed lateral to retract the tensor fascia lata retract the rectus femoris muscle inward, the anterior hip capsule is exposed. The anterior hip capsule is excised in a “L” shape. The anterior, superior and inferior capsules are excised, the femoral intertrochanteric line is exposed. Two retractors are placed superior and inferior to the femoral neck respectively. The femoral neck osteotomy is performed with two-cut technique to remove the femoral head. The hip synovium, labrum, and residual capsule are removed. Three retractors are placed along the anterior, superior and inferior of the acetabulum respectively, then the acetabulum and transverse ligament are exposed clearly. The acetabulum is then grinded to an appropriate size. A corresponding liner is impacted at an abduction angle of 40°-45° and anteverision angle of 15°, or reference to the implantation of transverse acetabular ligament into the acetabular cup. The proximal femur is elevated, and the osteotomy stump is then loosened to an appropriate extent. The hip is adducted, extended and externally rotated to expose the proximal femur. A specific retractor is placed at the rim of the greater trochanter, and double-pronged retractor is placed superior to the small trochanter. The femoral neck is fixed, and the medullary cavity is expanded and then grinded into an appropriate size. A femoral stem is implanted, and femoral components are installed. Reduction the hip, Check the muscle tension and joint stability. With good position and appropriate length assessed by C-arm fluoroscopy, trial components are removed to place the femoral head prosthesis.

1.4 Statistical methods

SPSS21.0 was used to analyze the data. Count data was described by the number of cases (%). Differences between statistical inference groups were tested by $X^2$. Measurement data consistent with normal distribution were expressed as mean ± standard deviation ($\bar{x}±s$), and group comparison was analyzed with student’s $t$-test. Non-normally distributed measurement data were described by median (quartile), and comparison among groups was analyzed by nonparametric Rank sum. In the multivariate correlation analysis via binary logistic regression model, the independent variables were significant factors evaluated by univariable analysis. The results were expressed by corrected odds ratios (OR) and corresponding 95% confidence interval (CI). Results were considered to be significant at $p<0.05$.

2 Results

A total of 261 patients (273 hips) were included in the analysis, of which 34 cases (35 hips) had femoral fractures, including 32 cases founded in operation, and 2 cases founded in the first postoperative X-ray. There were 29 greater trochanter fractures, 4 intertrochanteric and proximal femoral splits (fixation with steel wire,1.53%,4/261), 1 femoral perforation. The total incidence of fractures was 13.03% (34/261), with 9.09% in male and 17.05% in female, ($X^2=3.652; P=0.056$). There was no significant difference in fracture rates among ages and BMIs (Ages: $Z=-0.900; P=0.368$; BMIs: $Z=-0.426; P=0.670$). Osteoporosis was a risk factor for the increment of fracture incidence ($X^2=6.465; P=0.011$). There were significant differences in fracture
rates among heights and ASIS-GTDs (Z=-2.707; P=0.007; t=3.874; P=0.000). The fracture rate of different diseases was statistically significant (X^2=11.267; P=0.024). The data are shown in Table 1.

| Factors         | None fracture | Fracture group | X^2/t/Z   | P       |
|-----------------|---------------|----------------|-----------|---------|
| Gender          |               |                |           |         |
| Female          | 107(47.1)     | 22(64.7)       | 3.652*    | 0.056   |
| Male            | 120(52.9)     | 12(35.3)       |           |         |
| Age             | 64.000(52.000,73.000) | 63.500(55.250,75.000) | -0.900 Δ | 0.368   |
| Height(cm)      | 158.000(153.000,165.000) | 153.000(148.000,160.000) | -2.707 Δ | 0.007   |
| Disease         |               |                |           |         |
| FNF             | 95(41.9)      | 11(32.4)       |           |         |
| ONFH            | 85(37.4)      | 7(20.6)        |           |         |
| OA              | 21(9.3)       | 9(26.5)        |           |         |
| DDH             | 16(7.0)       | 5(14.7)        |           |         |
| Others          | 10(4.4)       | 2(5.9)         |           |         |
| ASIS-GTD(mm)    | 101.705±12.283| 92.885±13.031  | 3.874#    | 0.000   |
| Osteoporosis    |               |                |           |         |
| NO              | 157(69.2)     | 16(47.1)       | 6.465*    | 0.011   |
| Yes             | 70(30.8)      | 18(52.9)       |           |         |
| BMI (kg/m^2)    | 22.862(21.218,24.435) | 22.818(21.002,24.372) | -0.426 Δ | 0.670   |

The fracture rates of three height groups (≤150cm, 150~160cm, and >160cm, The fractures group were not identified in patients with a height of more than 170cm.) were 21.82%, 13.27% and 7.53%. The fracture rate declined significantly when the patient height was greater than 160cm (X^2=6.241; P=0.0441). The fracture rates of patients with (≤80mm, 80~90mm, 90~100mm, 100~110mm, and ≥110mm) ASIS-GTD were 58.3%, 30.95%, 4.17%, 11.11%, and 3.51%, respectively. The fracture rates were decreased along the increase of ASIS-GTD, when ASIS-GTD was greater than 90mm, the fracture rate decreased significantly (X^2=44.075; P=0.000). The fractures rates in different disease were different (X^2=11.267; P=0.024), femoral neck...
fracture (10.38%), osteonecrosis of femoral head (7.61%), osteoarthritis (30%), DDH (23.81%), and others (rheumatoid arthritis, ankylosing spondylitis, and coxa plana, 16.67%) (Figure c).

In a binary logistic regression analysis, the fracture incidence was used as a dependent variable, and hip diseases, ASIS-GTD, osteoporosis and patient height were used as independent variables. The results showed that there was a significant correlation between the fracture incidence with osteoporosis and ASIS-GTD, respectively (P<0.05). Patients with osteoporosis had a high possibility of fractures, which was 2.353 times higher than those without osteoporosis (OR=2.353). Increment of ASIS-GTD reduced the possibility of fractures. For each additional unit (mm), the fracture incidence was diminished by 0.061 times (OR=0.939). While hip diseases and patient height were not independent factors affecting fractures (P>0.05). The data are shown in Table 2,3.

| Factors   | assignment | Factors   | assignment |
|-----------|------------|-----------|------------|
| Fracture  | No 0       | Disease   |            |
|           | Yes 1      | FNF 1     |            |
| Osteoporosis | No 0   | OA 3      |            |
|           | Yes 1      | DDH 4     |            |
| ASIS-GTD  | Continuous variables | Others 5 |            |
| Height    | Continuous variables |          |            |
Table 3
Logistic regression analysis of fractures

| Factors    | β     | SE  | Wald | OR   | 95% CI       | P   |
|------------|-------|-----|------|------|--------------|-----|
|            | lower limit | Upper limit |
| Disease    | 5.883 |      |      |      |              |     |
| FNF        | Reference |       |      |      |              |     |
| ONFH       | -0.253 | 0.596 | 0.180 | 0.777 | 0.242 - 2.497 | 0.671 |
| OA         | 0.979 | 0.542 | 3.259 | 2.662 | 0.920 - 7.706 | 0.071 |
| DDH        | 0.689 | 0.646 | 1.137 | 1.992 | 0.561 - 7.073 | 0.286 |
| Others     | -0.205 | 0.908 | 0.051 | 0.815 | 0.137 - 4.833 | 0.822 |
| Osteoporosis | 0.856 | 0.434 | 3.880 | 2.353 | 1.004 - 5.514 | 0.049 |
| ASIS-GTD   | -0.062 | 0.021 | 9.178 | 0.939 | 0.902 - 0.978 | 0.002 |
| Height     | -0.005 | 0.030 | 0.031 | 0.995 | 0.938 - 1.055 | 0.860 |
| constant   | 4.481 | 4.239 | 1.117 | 88.294 |              | 0.290 |

β: Coefficient estimates; Wald: Chi-square value; OR: Odds Ratios; CI: Confidence Interval.

3 Discussion

With the development of ERAS in recent years, DAA had been giving more and more attention, and the utilization of DAA THA has been increased because its shorter invasive incision, less intraoperative bleeding, and improved recovery time. Many hospitals have carried out DAA THA and obtained satisfactory postoperative results[14]. With the increase of operations, however, various intraoperative or postoperative complications have emerged[15]. The incidence of femoral fractures varied between 0.1% and 22.4%[7,16-17]. In this retrospective study, all the operations were carried by an experienced surgeon. However, the incidence of femoral fractures was 13.03%, indicating that it was necessary to pay attention to femoral fractures. For the fracture rate in the study, it might have a relationship with the extensive indications and conventional stem. Many scholars set up strict selection criteria for DAA, such as ONFH, femoral neck fracture, no articular malformation and obvious activity limitation[18]. In this study, all the patients except hip ankylosis and severe deformity were selected to have DAA surgery. Figure 3C showed that patients with DDH, OA, and other inflammatory diseases accepted DAA THA had significant higher fracture incidence than those with femoral neck fracture and ONFH, indicating a certain influence of partial deformity, inflammatory diseases on the incidence of femoral fractures[19]. In addition, the femoral stems used in this study were conventional stems, not short stems[20]. Conventional stems need more space than shot stems, which may also have certain impacts on fractures. Fortunately, there were only 4 cases (1.53%) with fracture required
special treatment, indicating that lateral DAA THA could be successfully performed using conventional operation bed and conventional stem.

Some authors[15,18] reported that patients with obesity and advanced age were not suitable for DAA THA, the risk of complications such as fractures was high. In this study, patients had heterogenic BMIs, and the continuity analysis did not show that BMI had a significant effect on the incidence of fractures. Indeed, the lateral decubitus position may facilitate the exposure[21]. In the lateral decubitus position, the incision is at the highest point, and the peripheral tissues fall naturally away from the incision, so that patient stature and BMI have no significant impact on the operation. In addition, compared to supine position, the lateral position does not require special surgical bed, which reduces medical costs and conductive to the development of the technology. Figure 3B showed that the incidence of fractures risen with the increase of age, but without significant difference. The older you are, the higher the rate of osteoporosis[22]. So, the real cause of the increment of fracture incidence may be osteoporosis, not age and BMIs[23]. Of course, it was well documented that in DAA, osteoporosis causes the rise of fracture incidence[7], which was confirmed by this study also.

In DAA THA, the operation of the femur was difficult mainly due to the limited space between the anterior superior iliac spine and the greater trochanter. With similar conditions, the smaller the ASIS-GTD, the more difficult the femur exposure, leading to a higher incidence of fractures[24]. Compared with Europeans and Americans, Chinese are relatively short[25-26], which made femoral exposure and operation more difficult. Shang Xifu et al[27] reported that the difficulty of DAA surgery in patients with short femoral neck increased, and the quantification of femoral neck was complicated. In this study, ASIS-GTD was measured on the standard pelvic position, which was very simple. Both the univariate analysis and logistic regression analysis showed that ASIS-GTD was an independent influence factor for femoral fractures, the larger the ASIS-GTD, the lower the incidence of fractures. This could be explained by mechanics. As shown in figure d, proximal femur was exposed, the hip needed to be extended, adducted and externally rotated. An acetabular retractor was placed lateral to the greater trochanter to facilitate the exposure of the femoral neck anteriorly (F2). Except the hip capsule, the tractions were from posterior external rotation muscles and the posterior superior gluteus medius muscle (F1). The smaller the ASIS-GTD, the shorter of the muscle between the two, and the more difficult to expose the femur. During the exposure, F1 and F2 were in opposite directions. F2 may cause greater trochanter fracture, and F1 may cause greater trochanter avulsion fracture. In the surgical procedure, if the femoral tools were blocked by anterior superior iliac spine, an inward and downward shear force F3 would be generated during femoral stem grinding and implanting processes, which would cause intertrochanter and proximal femur fractures. In contrast, the greater the ASIS-GTD, the lower the risks were. Figure 3A showed the stratified analysis, in which the fracture incidence dropped with the increase of ASIS-GTD. The incidence of fractures tended to stabilize when ASIS-GTD reached 90mm. However, the fracture incidence fluctuated with ASIS-GTD was between 100mm and 110mm. After analyzing the specific cases, the results showed that the fluctuation was related to the high proportion of osteoarthritis and osteoporosis in the study.

For the exposure of proximal femur, many scholars had reported different methods in order to prevent femoral fractures[28,29]. After 3 years of practice, the authors have learned own experiences in releasing the
proximal femur. Similar to the method Chughtai et al reported[16], all the patients had anterior, inferior and superior capsules removal using conventionally methods to expose greater trochanter fossa and femoral neck. In this way, we completed the operation in some patients could successfully. Further releasing of piriformis and posterior external rotary muscles was needed for patients who still cannot complete the surgery. In addition, for patients with a particularly short femoral neck, it was necessary to increase osteotomy, which facilitated the exposure and adjustment of the lower limb length. With respect to high-edge polyethylene liner, if the femur was particularly difficult to expose, process the femur first, then install the liner and stem.

The muscle relaxation after anesthesia would influence the incidence of fractures. The deficiency of this study was the inconsistent anesthesia level., which may have some impact on the results of operation. Femur exposure in muscular patients was more difficulty in DAA THA[30], The anesthesia level needs to be controlled in further research.

In summary, lateral DAA THA could be successfully performed using conventional operation bed and conventional stem., which saved medical resources effectively. There was a significant correlation between fractures with osteoporosis and ASIS-GTD, respectively. Patients with osteoporosis were more likely to have fractures. The possibility of fractures declines with increase of ASIS-GTD. Patients with short stature, partial hip deformity, inflammatory arthroses had high level of risks. For high-risk patients, the surgeon should strengthen preoperative planning and increase the ASIS-GTD to reduce the incidence of fractures.

Levels of evidence: level III.

Declarations

Conflict of interest:

The authors declare that they have no conflict of interest.

Acknowledgements:

Thanks to Dr. Liu for her revision and guidance for English language.

References

1. Dailiana ZH, et al. Patient-reported quality of life after primary major joint arthroplasty: a prospective comparison of hip and knee arthroplasty. BMC Musculoskelet Disord. 2015;16:366. doi:10.1186/s12891-015-0814-9.

2. Siljander MP, Whaley JD, Koueiter DM, Alsaleh M, Karadsheh MS. Length of Stay, Discharge Disposition, and 90-Day Complications and Revisions Following Primary Total Hip Arthroplasty: A Comparison of the Direct Anterior, Posterolateral, and Direct Superior Approaches. J Arthroplast. 2020;35:1658–61. doi:10.1016/j.arth.2020.01.082.
3. Free MD, Owen DH, Agius PA, Pascoe EM, Harvie P. Direct Anterior Approach Total Hip Arthroplasty: An Adjunct to an Enhanced Recovery Pathway: Outcomes and Learning Curve Effects in Surgeons Transitioning From Other Surgical Approaches. J Arthroplast. 2018;33:3490–5. doi:10.1016/j.arth.2018.06.033.

4. Ripolles-Melchor J, et al. Association Between Use of Enhanced Recovery After Surgery Protocol and Postoperative Complications in Total Hip and Knee Arthroplasty in the Postoperative Outcomes Within Enhanced Recovery After Surgery Protocol in Elective Total Hip and Knee Arthroplasty Study (POWER2). JAMA surgery, e196024, doi:10.1001/jamasurg.2019.6024 (2020).

5. Petis S, Howard JL, Lanting BL, Vasarhelyi EM. Surgical approach in primary total hip arthroplasty: anatomy, technique and clinical outcomes. Can J Surg. 2015;58:128–39. doi:10.1503/cjs.007214.

6. Jia F, et al. A comparison of clinical, radiographic and surgical outcomes of total hip arthroplasty between direct anterior and posterior approaches: a systematic review and meta-analysis. Hip international: the journal of clinical experimental research on hip pathology therapy. 2019;29:584–96. doi:10.1177/1120700018820652.

7. Aggarwal VK, et al. Surgical approach significantly affects the complication rates associated with total hip arthroplasty. The bone joint journal. 2019;101-B:646–51. doi:10.1302/0301-620X.101B6.BJJ-2018-1474.R1.

8. Woolson ST. A survey of Hip Society surgeons concerning the direct anterior approach total hip arthroplasty. The bone joint journal. 2020;102-B:57–61. doi:10.1302/0301-620X.102B7.BJJ-2019-1493.R1.

9. Gkagkalis G, et al. Cementless short-stem total hip arthroplasty in the elderly patient - is it a safe option?: a prospective multicentre observational study. BMC Geriatr. 2019;19:112. doi:10.1186/s12877-019-1123-1.

10. Foissey C, et al. Transitioning the total hip arthroplasty technique from posterior approach in lateral position to direct anterior approach in supine position-risk factors for acetabular malpositioning and the learning curve. International orthopaedics. 2020. doi:10.1007/s00264-020-04583-0.

11. Cook R, Lamont T, Martin R, Centre ND. A traditional hip implant is as effective as newer types for people over 65. Bmj. 2019;366:l4230. doi:10.1136/bmj.l4230.

12. Yanik JM, et al. Rapid Recovery Total Joint Arthroplasty is Safe, Efficient, and Cost-Effective in the Veterans Administration Setting. J Arthroplast. 2018;33:3138–42. doi:10.1016/j.arth.2018.07.004.

13. Zhu Yayuan Z. J. cost-effectiveness analysis of different artificial prostheses in total hip preplacment. Jiangsu Medical Journal. 2016;42:3.

14. Maldonado DR, et al. Direct anterior approach versus posterior approach in primary total hip replacement: comparison of minimum 2-year outcomes. Hip international: the journal of clinical experimental research on hip pathology therapy, 1120700019881937, doi:10.1177/1120700019881937 (2019).

15. Sali E, Marmorat JL, Gaudot F, Nich C. Perioperative complications and causes of 30- and 90-day readmission after direct anterior approach primary total hip arthroplasty. Journal of orthopaedics. 2020;17:69–72. doi:10.1016/j.jor.2019.08.006.
16. Chughtai M, Samuel LT, Acuna AJ, Kamath AF. Algorithmic soft tissue femoral release in anterior approach total hip arthroplasty. Arthroplasty today. 2019;5:471–6. doi:10.1016/j.artd.2019.10.004.

17. Lv M, et al. [Surgical technique and early clinical outcomes of direct anterior approach to total hip arthroplasty]. Beijing da xue xue bao Yi xue ban = Journal of Peking University Health sciences. 2017;49:206–13.

18. Dall'Oca C, et al. Facing complications of direct anterior approach in total hip arthroplasty during the learning curve. Acta bio-medica: Atenei Parmensis. 2020;91:103–9. doi:10.23750/abm.v91i4-S.9728.

19. Herndon CL, et al. Direct anterior versus mini-anterolateral approach for primary total hip arthroplasty: early postoperative outcomes and complications. Arthroplasty today. 2020;6:257–61. doi:10.1016/j.artd.2020.02.009.

20. Greco NJ, Lombardi AV Jr, Morris MJ, Hobbs GR, Berend KR. Direct Anterior Approach and Perioperative Fracture With a Single-Taper Wedge Femoral Component. J Arthroplast. 2019;34:145–50. doi:10.1016/j.arth.2018.09.003.

21. Guler O, Ozturk S, Ozgezmez FT, Cerci MH Comparison of Supine and Lateral Decubitus Positions for Total Hip Arthroplasty with the Direct Lateral Approach in Overweight and Obese Patients. BioMed research international 2020, 8684067, doi:10.1155/2020/8684067 (2020).

22. Force USPST, et al. Interventions to Prevent Falls in Community-Dwelling Older Adults: US Preventive Services Task Force Recommendation Statement. Jama. 2018;319:1696–704. doi:10.1001/jama.2018.3097.

23. Flury A, et al. Should advanced age be a contraindication to total hip arthroplasty in femoral neck fracture patients? A matched-control, retrospective study. Journal of orthopaedics. 2020;17:25–9. doi:10.1016/j.jor.2019.08.007.

24. Sang W, Zhu L, Ma J, Lu H, Wang C. The Influence of Body Mass Index and Hip Anatomy on Direct Anterior Approach Total Hip Replacement. Medical principles practice: international journal of the Kuwait University Health Science Centre. 2016;25:555–60. doi:10.1159/000447455.

25. Habibov N, Luo R, Auchynnikava A, Fan L. Height and life satisfaction: Evidence from 27 nations. American journal of human biology: the official journal of the Human Biology Council. 2020;32:e23351. doi:10.1002/ajhb.23351.

26. Yu Keli LY, Huanjiu X. Zhang Lianbin,Lu Shunhua,,Wen Youfeng, Bao Jinping, Zhang Xinghua Comparisons of mean stature, body weight between Chinese Han and Japanese or Korean. Journal of Tianjin Normal University(Natural Science Edition). 2016;36:5.

27. Yang XT, et al. Direct Anterior Approach Versus Posterolateral Approach in Total Hip Arthroplasty: A Systematic Review and Meta-analysis of Randomized Controlled Studies. Orthopaedic surgery. 2020. doi:10.1111/os.12669.

28. Zomar BO, Bryant D, Hunter S, Howard JL, Lanting BA. The effect of conjoint tendon release on gait after direct anterior total hip arthroplasty. Hip international: the journal of clinical experimental research on hip pathology therapy. 2019;29:578–83. doi:10.1177/1120700018813547.

29. Post ZD, Orozco F, Diaz-Ledezma C, Hozack WJ, Ong A. Direct anterior approach for total hip arthroplasty: indications, technique, and results. J Am Acad Orthop Surg. 2014;22:595–603.
doi:10.5435/JAAOS-22-09-595.

30. Cichos KH, et al. A Comparison Between the Direct Anterior and Posterior Approaches for Total Hip Arthroplasty Performed for Femoral Neck Fracture. J Orthop Trauma. 2020.

doi:10.1097/BOT.0000000000001883.