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The Influence of Body Mass Index and Hip Anatomy on Direct Anterior Approach Total Hip Replacement

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Key Words
Direct anterior approach · Hip replacement · Body mass index · Anatomy

Abstract
Objective: To investigate the influence of body mass index (BMI) and hip anatomy on direct anterior approach (DAA) total hip replacement. ***Subjects and Methods:*** The study is a retrospective analysis of 124 cases of DAA total hip replacement from 2009 to 2012. The BMI, the ratio of the greater trochanter (GT) and anterior superior iliac spine (ASIS) bilaterally (GT/ASIS), and the vertical distance between the ASIS and GT (AGVD) were obtained from medical records. All cases were categorized into three groups (43, 49, and 32 cases in each group, respectively) based on BMI (BMI <18.5, BMI 18.5–25, and BMI >25) or divided into two groups based on GT/ASIS (≤1.17 or >1.17) or AGVD (≤86 or >86 mm). Operating time, intraoperative bleeding, and surgical complications were compared between different groups. ***Results:*** A longer average operating time, more intraoperative bleeding, and a higher rate of complications were observed in the group with the highest BMI. The complications included a case of intraoperative femur fracture, a wound hematoma, and a lateral femoral cutaneous nerve injury. The group with higher GT/ASIS had a shorter average operating time, less bleeding, and a lower complication rate than the group with lower GT/ASIS. Moreover, the group with higher AGVD showed a shorter average operating time, less bleeding, and a lower complication rate compared with the group with lower AGVD. ***Conclusion:*** Our study suggests that lower BMI and larger GT/ASIS and AGVD are associated with a shorter operating time, less bleeding, and a lower complication rate in DAA total hip replacement. These findings are valuable for clinicians to make the appropriate choice of surgery types for different individuals.

Introduction

Being one of the most successful surgeries, hip replacement has saved tens of thousands of hips in more than half a century [1]. Nevertheless, joint surgeons have not stopped exploring a better operating method for hip replacement. In recent years, minimally invasive total hip replacement has become a popular choice [2]. The direct anterior approach (DAA) is widely used for minimally invasive total hip replacement in North America, Europe, and Asia [3]. Noticeably, the DAA hip replacement causes

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less soft tissue trauma than other surgical approaches, because it follows internervous and intermuscular planes, specifically the anatomic space between the tensor fasciae latae and sartorius muscles [3, 4]. Indeed, DAA total hip replacement, compared with the traditional operation, has shorter operating times, less bleeding, quicker recovery, and lower dislocation rates [5, 6].

Since 2008, our Joint Surgery Center has completed more than 200 DAA total hip replacements. Although it is a very effective minimally invasive hip replacement operation, we found that the exposure and manipulation of the femur side is a big challenge to this technique, which not only increases the operating time and bleeding but also leads to various complications. The reported femur fracture rate of DAA is ≥2.7% [7–10]. In our clinical practice, we noticed that patients with different body mass index (BMI) or hip anatomy tend to have different postoperative outcomes. However, no study has discussed patient selection strategies of DAA hip replacement. This retrospective study focused on the influence of BMI and hip anatomy, specifically the relationship between the greater trochanter (GT) and the anterior superior iliac spine (ASIS), on DAA total hip replacement outcomes.

Materials and Methods

The study included 124 cases (age 40–80 years) of DAA total hip replacement performed between 2009 and 2012, including 53 acute femoral neck fractures, 27 osteoarthritis of the hip, 34 femoral head avascular necrosis, and 10 rheumatoid hip arthritis. The average age was 67.3 ± 6.5 years. The exclusion criteria were old fractures of the femoral neck, hip dysplasia, revision cases, and a history of ipsilateral hip surgery.

Surgical Procedure

The patients were placed in the supine position after inducing anesthesia. The ASIS and GT were identified. A 6- to 7-cm incision was made at about 4 cm distal and 4 cm lateral to the ASIS. The subcutaneous tissues were separated and the tensor fascia latae exposed. The fascia over the tensor fascia latae was cut through and was gently retracted laterally in order to expose the distal part of the Smith-Peterson interval. The branches of the lateral circumflex femoral vessels were carefully separated and ligated. The fascia between the rectus femoris muscle and tensor fascia latae was cut through, and the anterior part of the hip joint capsule was exposed using four sharp retractors. The anterior part of the hip capsule was cut off, and the femoral neck was encircled with two blunt retractors. The first osteotomy was made about 1 cm above the lesser trochanter medially, and then the second osteotomy was made about 1 cm above and parallel to the first cut. Generally, a second osteotomy is not needed in femoral neck fractures. The osteotomy and femoral head were then removed.

The acetabulum was prepared with a double-offset acetabular reamer after removing the labrum and osteophytes around the acetabulum. The acetabular prosthesis and lining were implanted. Descending the distal part of the surgical bed by about 30°, the limb was adducted and rotated externally to expose the proximal femur. The posterolateral capsule was released, and the proximal femur was lifted with a bone hook and a Müller retractor under the GT for a better view. The gluteus minimus, the gemellus superior and inferior, and the internal obturator muscles attached to the medial part of the GT could be released if there was any difficulty with the exposure, but could not be cut off. Then the femur side was prepared with a double-offset femur reamer. The femur and head prosthesis were implanted, and the hip joint was reduced. The hip joint activity and stability were checked, and the incision was closed. All 124 procedures were performed by four physicians (J.M., L.Z., W.S., and H.L.), and the same set of DAA minimally invasive surgical tools was used. The Accolade femur prosthesis and Trident acetabular cups were from Stryker.

Measurements

The weight and height of each patient (measured in kilograms and meters, respectively) were obtained from medical records to calculate the BMI. The average BMI of these cases was 21.8 ± 3.2. The operating time, amount of intraoperative bleeding, and surgical complications were obtained from medical records and analyzed.

The distances to the GT and ASIS bilaterally and the vertical distance between the ASIS and GT (AGVD) were measured on the supine pelvic X-rays (mean magnification percentage: 1.07) using the PACS radiation software (Rogan-Delft, The Netherlands). First, a line was drawn at the lateral border of both GT. Then, another line was drawn parallel through both ASIS. The length of the two lines was used to calculate the ratio GT/ASIS. The vertical distance between the two lines on the X-rays was the AGVD (fig. 1). In the cases of femoral neck fracture, a line between the lateral border of the healthy GT and the midpoint of the symphysis pubis was used for the measurement of AGVD (fig. 2), and the distance from the GT to the symphysis pubis was doubled for calculating GT/ASIS. The mean GT/ASIS and AGVD were 1.17 ± 0.02 and 85.9 ± 1.4 mm, respectively.

We grouped patients according to their BMI and the distance between GT and ASIS both on the coronal plane and vertical direction, retrospectively. Three categorization standards were adopted to group all the cases: BMI, GT/ASIS, and AGVD. Firstly, the patients were divided into three groups according to the World Health Organization BMI classification standard: group 1 – low body weight with a BMI <18.5, group 2 – normal body weight with BMI 18.5–25, and group 3 – obese with BMI >25. Based on the BMI classification, 43, 49, and 32 cases were included in groups 1–3, respectively. The average operating time, intraoperative bleeding, and complications were compared among the three groups.

All the patients were divided into two groups based on the GT/ASIS: group 1 ≤1.17 and group 2 >1.17, as well as divided into two groups according to the AGVD: group 1 ≤86 mm and group 2 >86 mm. With the GT/ASIS grouping standard, 70 cases were included in group 1 (GT/ASIS ≤1.17) and 54 were included in group 2 (GT/ASIS >1.17). With the AGVD grouping standard, 58 cases were included in group 1and 66 were included in group 2. The average operating time, intraoperative bleeding, and complications were compared between each pair of groups.

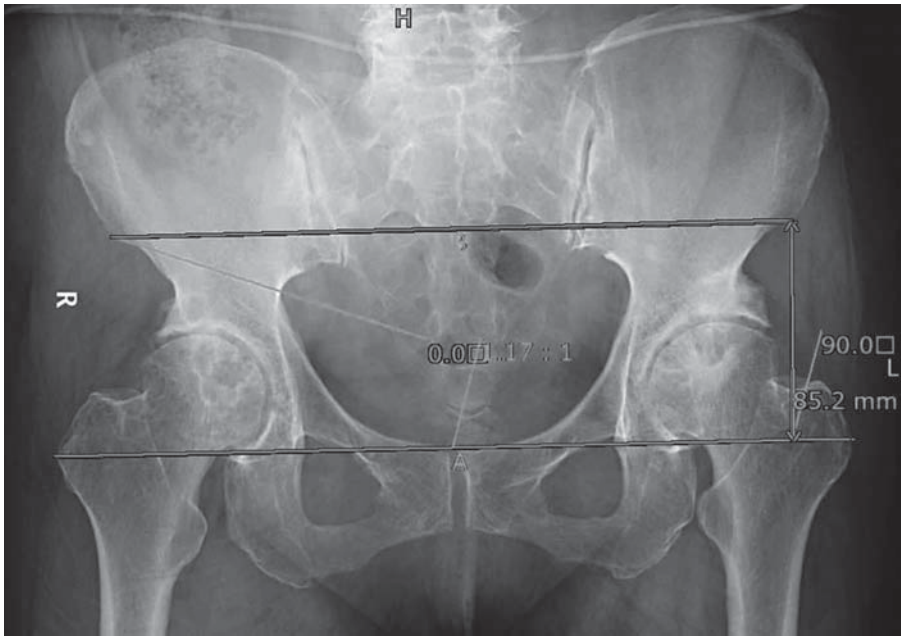

Fig. 1. Measuring GT/ASIS and AGVD of nonfemoral neck fracture cases.

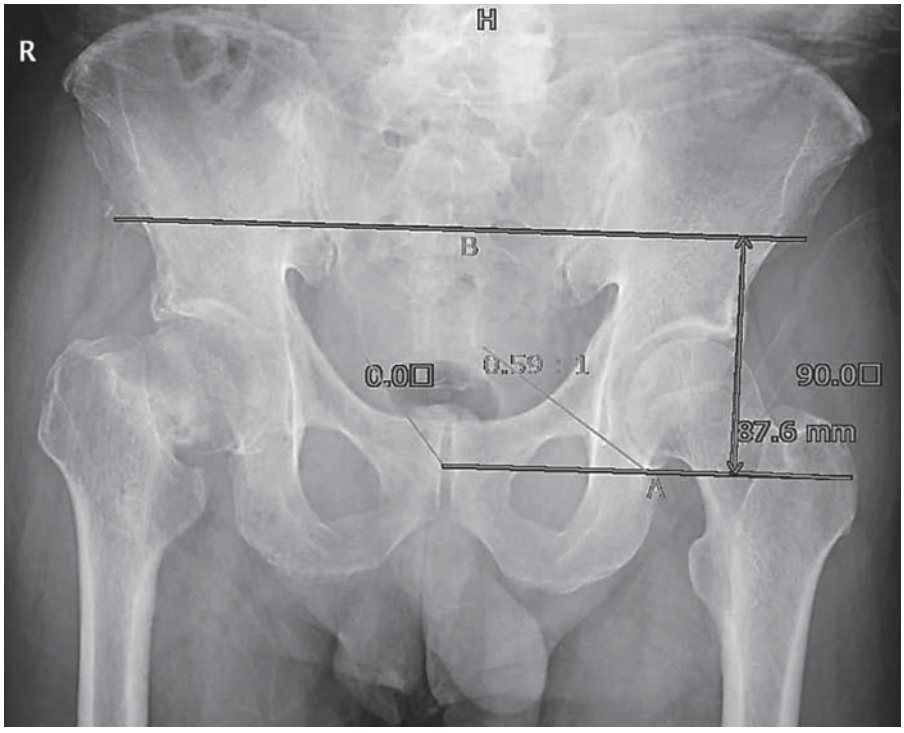

Fig. 2. Measuring GT/ASIS and AGVD of femoral neck fracture cases.

Statistical Analysis

The operating time and intraoperative bleeding were compared using the unpaired t test. The analyses were performed using SPSS for Windows, version 11.0 (SPSS, Chicago, Ill., USA), and the level of significance was set at 95%.

Results

The mean operating time of group 1 (75.3 ± 16.0 min) was significantly shorter than in group 2 (79.2 ± 18.1 min, p = 0.032) and group 3 (88.5 ± 14.3 min, p = 0.024) based on BMI classification. The mean volume of intraoperative

Table 1. Data according to BMI classification

BMI	Cases, n	Rate, %	Operating time, min	Intraoperative bleeding, ml	Complications, n (%)
Group 1 (BMI <18.5)	43	34.7	75.3±16.0	347.6±153.1	0 (0)
Group 2 (BMI 18.5–25)	49	39.5	79.2±18.1*	390.0±161.4*	1 (2.0)
Group 3 (BMI >25)	32	25.8	88.5±14.3*	510.9±158.3*	2 (6.3)

* $p < 0.05$.

Table 2. Data according to GT/ASIS classification

GT/ASIS	Cases, n	Rate, %	Operating time, min	Intraoperative bleeding, ml	Complications, n (%)
Group 1 (≤1.17)	70	56.5	87.5±17.2	486.8±137.2	2 (2.9)
Group 2 (>1.17)	54	43.5	77.9±16.0*	365.7±150.1*	1 (1.9)

* $p < 0.05$.

Table 3. Data according to AGVD classification

AGVD	Cases, n	Rate, %	Operating time, min	Intraoperative bleeding, ml	Complications, n (%)
Group 1 (≤86 mm)	58	46.8	85.0±15.7	460.2±147.3	3 (5.2)
Group 2 (>86 mm)	66	53.2	82.4±16.8	435.5±138.3	0 (0)

bleeding of group 1 (347.6 ± 153.1 ml) was also less than in group 2 (390.0 ± 161.4 ml) and group 3 (510.9 ± 158.3 ml, $p < 0.05$). Moreover, no surgery complication was observed in group 1, whereas 1 case of complication (GT fracture) occurred in group 2 (2.0%), and 2 cases (1 lateral circumflex femoral artery hematoma and 1 lateral femoral cutaneous nerve injury) were seen in group 3 (6.3%) (table 1).

The mean operating time (77.9 ± 16.0 min) and the volume of intraoperative bleeding (365.7 ± 150.1 ml) in group 2 were significantly less than the corresponding values of group 1 (87.5 ± 17.2 min and 486.8 ± 137.2 ml, respectively, $p < 0.05$) based on the GT/ASIS grouping standard. The complication rate was 2.9% in group 1 (1 GT fracture and 1 lateral circumflex femoral artery hematoma) and 1.9% in group 2 (1 lateral femoral cutaneous nerve injury) (table 2).

The average operating time and the volume of intraoperative bleeding in group 2 were 82.4 ± 16.8 min and 435.5 ± 138.3 ml, respectively, and they were less than in group 1 (85.0 ± 15.7 min and 460.2 ± 147.3 ml) based on the AGVD grouping standard, but the differences were not significant ($p > 0.05$). There were 3 complications (1 fracture, 1 hematoma, and 1 lateral femoral cutaneous nerve injury) in group 1 (5.2%) and none in group 2 (table 3).

Discussion

A longer average operating time, more intraoperative bleeding, and a higher rate of complications were found in the higher BMI cases in DAA total hip replacement. What is more, the cases with higher GT/ASIS had a shorter average operating time, less bleeding, and lower complication rate than the group with lower GT/ASIS. Moreover, the group with higher AGVD also showed a shorter average operating time, less bleeding, and a lower complication rate compared with the group with lower AGVD in this study. Many minimally invasive total hip replacement procedures have been used worldwide in recent

years. Of these, the DAA is one of the most popular. It is a true minimally invasive procedure because it follows internervous and intermuscular planes. No muscles around the hip joint are cut off, so the DAA has the advantages of a faster recovery and a lower posterior dislocation rate [11–15]. However, this approach is not suitable for all hip replacements. As far as we know, there are no studies focused on the relationship between hip anatomy and DAA surgery in the literature.

In this study, we found that the underweight group (BMI <18.5) had a shorter operation time, less bleeding, and lower complication rates compared with the healthy weight or overweight groups. It suggests that BMI has some impact on the outcomes of DAA total hip replacement. BMI is one of the factors that influence operations on the hip, especially in minimally invasive total hip arthroplasty. Obesity has been thought to be directly related to the operating time [16, 17]. Recently, the American Association of Hip and Knee Surgeons Evidence-Based Committee recommended against elective total hip arthroplasty in patients with a BMI >40. This recommendation also applies to the use of the DAA [3, 18].

More importantly, hip anatomy also plays an important role in DAA minimally invasive hip replacement. In this study, GT/ASIS represents the distance between the GT and ASIS on the coronal plane, while AGVD represents the vertical distance. Our results showed that the shorter the distance the less the operation time, bleeding, and complications. A number of DAA procedures, which resulted in a large number of GT fractures and other complications, occurred frequently in the femoral side, which was related to the anatomical location of the hip joint. If the distance between the GT and ASIS is too short in the vertical direction or the GT is more medial to the ASIS on the coronal plane, the surgical procedure will be difficult. The difficulty with acetabular preparation is dependent on the cases, while femoral exposure is always difficult in DAA surgery. Therefore, DAA hip arthroplasty requires a learning curve, which is reported to be 40, 60, or even more than 100 cases [9, 19–22]. So the DAA may be avoided during the learning curve of surgeons. The increased time of femoral exposure not only increases the operating time and bleeding but can also lead to femur fractures [23, 24].

Femur exposure is the difficult point of this procedure. In most cases, hyperextension, adduction, and external rotation of the lower extremity are sufficient for exposure [3]. However, in some cases, soft tissue debonding of the GT tip is needed to help to lift and expose the proximal femur using a Müller retractor. However, in some fat or muscular patients or those with unusual hip anatomy, the femoral exposure and operation are very laborious. Due to the deep location of the proximal femur, the ASIS often makes this procedure difficult. Skin and soft tissue contusions at the ASIS caused by friction during the femoral trial are frequent, even using a double-offset instrument, which can lead to more wound and soft tissue complications. The reported rate of postoperative wound complications with the DAA is up to 1.4%, higher than with the traditional posterolateral approach [25].

Although many reports indicated that DAA minimally invasive hip replacement had better early postoperative outcomes [12, 14, 15], case selection might be a more important factor than the operative approach [26]. Our study retrospectively analyzed 124 cases of direct anterior hip replacement. The results were similar to those of Hungerford et al. [27]. Nonetheless, we found the distance between ASIS and GT was an important factor which may influence the procedure and its outcomes. Therefore, we conclude that BMI and hip anatomy should be considered before deciding to perform a DAA hip replacement.

Generally, this was a retrospective study, and earlier cases of the learning curve were also included, which might have influenced the results. A prospective study will be helpful to determine a causal effect of BMI and hip anatomy on surgery outcomes.

References

1 Ethgen O, Bruyère O, Richy F, et al: Health-related quality of life in total hip and total knee arthroplasty. A qualitative and systematic review of the literature. J Bone Joint Surg Am 2004;86-A:963.

2 Rohith M, Paul HY, Erik NH: Evaluating online information regarding the direct anterior approach for total hip arthroplasty. J Arthroplasty 2015;30:803–807.

3 Post ZD, Orozco F, Diaz-Ledezma C, et al: Direct anterior approach for total hip arthroplasty: indications, technique, and results. J Am Acad Orthop Surg 2014;22:595–603.

4 Ilchmann T: Approaches for primary total hip replacement. Hip Int 2014;24:S2–S6.

5 Sachiyuki T, Motohiro W: Lower dislocation rate following total hip arthroplasty via direct anterior approach than via posterior approach: five-year-average follow-up results. Open Orthop J 2015;9:157–162.

6 Christensen CP, Jacobs CA: Comparison of patient function during the first six weeks after direct anterior or posterior total hip arthroplasty (THA): a randomized study. J Arthroplasty 2015;30:94–97.
7 Rüdiger HA, Betz M, Zingg PO, et al: Outcome after proximal femoral fractures during primary total hip replacement by the direct anterior approach. Arch Orthop Trauma Surg 2013;133:569–573.
8 Berry DJ: Epidemiology: hip and knee. Orthop Clin North Am 1999;30:183–190.
9 Spaans AJ, van den Hout JA, Bolder SB: High complication rate in the early experience of minimally invasive total hip arthroplasty by the direct anterior approach. Acta Orthop 2012;83:342–346.
10 Jewett BA, Collis DK: High complication rate with anterior total hip arthroplasties on a fracture table. Clin Orthop Relat Res 2011; 469:503–507.
11 Nakata K, Nishikawa M, Yamamoto K, et al: A clinical comparative study of the direct anterior with mini-posterior approach: two consecutive series. J Arthroplasty 2009;24:698–704.
12 Barrett WP, Turner SE, Leopold JP: Prospective randomized study of direct anterior vs postero-lateral approach for total hip arthroplasty. J Arthroplasty 2013;28:1634–1638.
13 Alecci V, Valente M, Crucil M, et al: Comparison of primary total hip replacements performed with a direct anterior approach versus the standard lateral approach: perioperative findings. J Orthop Traumatol 2011;12: 123–129.
14 Taunton MJ, Mason JB, Odum SM, et al: Direct anterior total hip arthroplasty yields more rapid voluntary cessation of all walking AIDS: a prospective, randomized clinical trial. J Arthroplasty 2014;29:169–172.
15 Zawadsky MW, Paulus MC, Murray PJ, et al: Early outcome comparison between the direct anterior approach and the mini-incision posterior approach for primary total hip arthroplasty: 150 consecutive cases. J Arthroplasty 2014;29:1256–1260.
16 von Roth P, Olivier M, Preininger B, et al: BMI and gender do not influence surgical accuracy during minimally invasive total hip arthroplasty. Hip Int 2011;21:688–693.
17 Wang JL, Gadinsky NE, Yeager AM, et al: The increased utilization of operating room time in patients with increased BMI during primary total hip arthroplasty. J Arthroplasty 2013; 28:680–683.
18 Workgroup of the American Association of Hip and Knee Surgeons Evidence-Based Committee: Obesity and total joint arthroplasty: a literature based review. J Arthroplasty 2013;28:714–721.
19 Woolson ST, Puoliot MA, Huddleston JI: Primary total hip arthroplasty using an anterior approach and a fracture table: short-term results from a community hospital. J Arthroplasty 2009;24:999–1004.
20 D'Arrigo C, Speranza A, Monaco E, et al: Learning curve in tissue sparing total hip replacement: comparison between different approaches. J Orthop Traumatol 2009;10:47–54.
21 Goytia RN, Jones LC, Hungerford MW: Learning curve for the anterior approach total hip arthroplasty. J Surg Orthop Adv 2012;21: 78–83.
22 Bhandari M, Matta J M, Dodgin D, et al: Outcomes following the single-incision anterior approach to total hip arthroplasty: a multicenter observational study. Orthop Clin North Am 2009;40:329–342.
23 Asayama I, Kinsey TL, Mahoney OM: Two-year experience using a limited-incision direct lateral approach in total hip arthroplasty. J Arthroplasty 2006;21:1083–1091.
24 De Geest T, Vansintjan P, De Loore G: Direct anterior total hip arthroplasty: complications and early outcome in a series of 300 cases. Acta Orthop Belg 2013;79:166–173.
25 Christensen CP, Karthikeyan T, Jacobs CA: Greater prevalence of wound complications requiring reoperation with direct anterior approach total hip arthroplasty. J Arthroplasty 2014;29:1839–1841.
26 Poehling-Monaghan KL, Kamath AF, Taunton MJ, et al: Direct anterior versus miniposterior THA with the same advanced perioperative protocols: surprising early clinical results. Clin Orthop Relat Res 2015;473: 623–631
27 Hungerford MW, Schuh R, O'Reilly MP, et al: Outcome of minimally invasive hip replacement in obese, overweight, and nonobese patients. J Surg Orthop Adv 2014;23:68–74.