CLINICAL ARTICLE

Direct Anterior Approach Provides Superior Prosthesis Adaptability in the Early Postoperative Period of Total Hip Arthroplasty

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Objectives: Prosthesis awareness is the perception of foreign bodies, which has a critical effect on the function of the prosthetic joint. In total hip arthroplasty (THA), the direct anterior approach (DAA) has more advantages than the posterior approach (PA), including superior rehabilitation outcomes. This study was to evaluate the recovery of "prosthesis awareness" through these two approaches.

Methods: Three hundred and seventy-six patients who received THA with either DAA (n = 41) or PA (n = 335) from January 2016 to December 2017 were retrospectively analyzed. The Forgotten Joint Score-12 (FJS-12), Harris hip score (HHS), and visual analog scale (VAS) analyses were used to evaluate the recovery of "prosthesis awareness" in these patients 2 weeks, 1, 3, 6, and 12 months after surgery. The student *t*-test, Wilcoxon rank sum test, chi-square test, and MANOVA were used to compare the differences among groups.

Results: We found that DAA patients had higher FJS-12 scores than PA patients at 2 weeks (42.15 ± 3.36 vs. 38.09 ± 3.28, $p = 0.042$), 1 month (49.06 ± 5.14 vs. 41.11 ± 5.21, $p = 0.038$), and 3 months (53.23 ± 4.07 vs. 48.09 ± 3.71, $t = 3.152$, $p = 0.045$). And the recovery rates of FJS-12 scores in DAA and PA groups at 2 weeks, 1 month, and 3 months after surgery were $75.46\% \pm 6.04\%$, $84.05\% \pm 6.57\%$, $91.37\% \pm 7.13\%$, and $74.14\% \pm 5.54\%$, $78.16\% \pm 6.01\%$, $88.23\% \pm 6.42\%$, respectively. To compare the recovery effects of the two procedures in more detail, we classified the 12 items in FJS-12 that evaluate different types of gravity center motions into three categories: low-movement group (LG), middle-movement group (MG), and high-movement group (HG). Interestingly, DAA patients had significantly higher HG than PA patients at 2 weeks, 1 month, and 3 months after operation ($t = 3.225$, $p = 0.022$ at 2 weeks, $t = 3.081$, $p = 0.041$ at 1 month and $t = 2.783$, $p = 0.046$ at 3 months), whereas no significant differences were observed in LG- and MG-related items. In addition, there were no significant differences in HHS and VAS scores between DAA and PA patients at 2 weeks ($p = 0.102$, $p = 0.093$), or from 1 month to 12 months (each $p > 0.05$).

Conclusions: DAA-mediated THA is superior to PA in terms of prosthesis adaptability and recovery of hip joint motion in the first 3 months after surgery, especially concerning high-movement gravity center motions.

Key words: Direct Anterior Approach; Posterior Approach; Prosthesis Awareness; Retrospective Study; Total Hip Arthroplasty

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Introduction

Total hip arthroplasty (THA) has been used widely for hip pain relief and functional recovery. Although many surgical approaches have been developed, no consensus has been reached on the optimal approach.[1] The posterior approach (PA) is one the most popular approaches given its convenience, allowing sufficient visualization of the hip joint; hence, it is the most applied approach for THA.[2]

In recent years, the direct anterior approach (DAA) has attracted much attention for its advantages, including less injury to muscle and nerve plane,[3] greater pain relief,[4,5] faster rehabilitation,[6,7] and lower dislocation rate,[8,9] which account for the increase in the number of patients treated with DAA.[10] Moreover, DAA is conducive to less soft tissue damage,[11] and offers improved early outcomes in terms of pain, rehabilitation, and length of stay.[10,12]

A prosthesis awareness is described as feeling a foreign body sensation by the patient, in terms of how much patients are aware of their prosthesis overall, or whilst engaging in tasks. It comes from the proprioception sensory system that is involved with where the body is, how the body moves, and awareness of self. A better prosthesis awareness representative of higher-level function after surgery, as to be able to forget about the joint, requires the absence of pain and the ability to perform all desired functional tasks without limitation.[13] Nonetheless, the recovery of "prosthesis awareness" has been largely underexplored between DAA and PA patients. We hypothesized that DAA would lead to a lower incidence of early "prosthesis awareness" and could improve the clinical outcome. Similarly, the Forgotten Joint Score-12 (FJS-12) has previously been used to compare the difference in prosthesis awareness and activity recovery in THA patients.[9]

The aims of the retrospective study were to (i) compare the recovery of "prosthesis awareness" by the scale of FJS-12 in THA patients between DAA and PA procedure; (ii) provide a comprehensive overview of DAA on superior recovery of hip joint motion and physical activity; (iii) recommend clinicians prioritize the use of FJS-12 to evaluate high-movement gravity center motions after THA.

Patients and Methods

Study Design and Participants

Patients that underwent total hip arthroplasty (THA) performed by the same three surgeons in our institution from January 2016 to December 2017 were retrospectively analyzed. The prostheses used in all patients were TRI-LOCK®/CORAIL® Bone Preservation Stems, which were supplied by DePuy Synthes (United States). The inclusion criteria were: (i) adult patients aged 18 years or older, (ii) THA for the first time, (iii) follow rehabilitation program, and (iv) normal memory that can remember hip condition changes after surgery. The exclusion criteria were: (i) history of rheumatic arthritis, (ii) previous lower extremity joint surgery such as TKA surgery, joint revision surgery, (iii) postoperative prosthesis-related complications, and (iv) preoperative neurovascular disease (DVT, decreased mobility after stroke). This study was approved by The Ethics Committee of The First Affiliated Hospital of Zhejiang Chinese Medical University (2019-K-306-01) and was conducted at The First Affiliated Hospital of Zhejiang Chinese Medical University. All operations were carried out in accordance with the ethical standards in the 1964 Declaration of Helsinki.

Demographic Information

The analyzed clinical parameters included age, gender, body mass index (BMI), surgical indication, blood test results (C-reactive protein [CRP], albumin and D-dimer from venous blood, and lactic acid from artery blood), past medical history (diabetes mellitus, hypertension, coronary heart disease, myocardium infarction [MI], deep vein thrombosis [DVT]), history of antiplatelet drug use (aspirin or clopidogrel), anesthesia type, surgery time, blood loss, postoperative drainage, and time of weight bearing (partial or full weight). According to the WHO criteria,[14] BMI was divided as follows: low weight (BMI < 18.5 kg/m^2), normal (BMI 18.5–25 kg/m^2), overweight (BMI 25–30 kg/m^2), obesity I grade (BMI 30–35 kg/m^2), obesity II grade (BMI 35–40 kg/m^2), obesity III grade (BMI > 40 kg/m^2). The Charlson comorbidity index (CCI) was used and stratified into three levels: low level (0) means no comorbidity, middle level (1, 2), and high level (≥3).[15]

Operative Procedures

All operations were performed according to the standard procedure. The surgical method is recommended by the surgeon and patients agree. After anesthesia, the DAA patients were placed in the supine position, the low limb was placed on the traction table, and the PA patients were placed on the operating table in the lateral position. DAA enters the hip joint through the intermuscular interval between the lateral fascia lata extensor and gluteus medius, and the medial sartorius and rectus fasciae.[16] PA is the most common and practical method for hip joint exposure and total hip replacement surgery in the past three decades.

Rehabilitation Procedures

The same perioperative protocol and rehabilitation exercise were applied for DAA and PA. Passive hip flexion and extension was exercised right after the operation. Partial weight bearing was initiated on postoperative day one or two, and full weight bearing was performed at 5–7 days. Patients that underwent THA *via* DAA were instructed not to extend and externally rotate the lower limb. Patients that underwent PA were instructed not to hyper flex, adduct, and internally rotate the lower limb.

Observation Indicators

The primary outcome was FJS-12, the secondary outcomes were Harris hip score (HHS) and visual analogue scale (VAS). The standard follow-up form was created and included all questions about FJS-12, HHS, and VAS. All

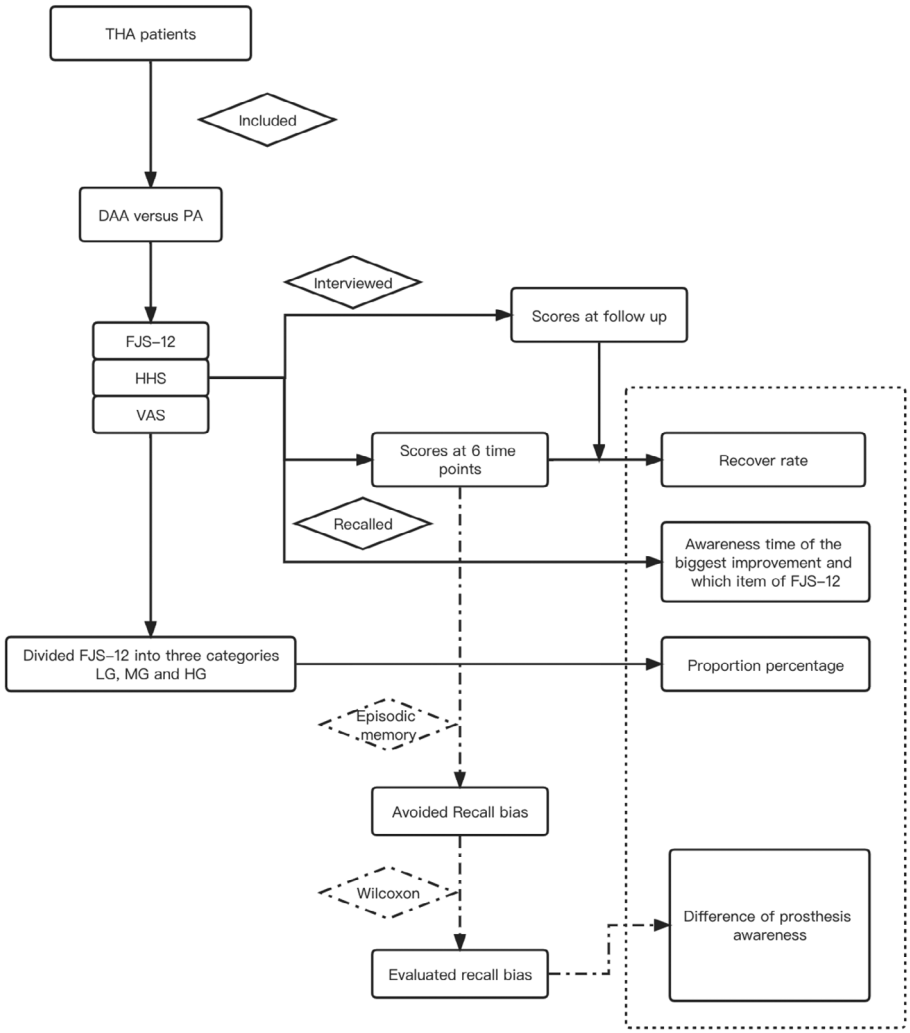

FIGURE 1 The flowchart of the follow-up process in this study

patients were followed up by telephone and returned to the outpatient clinic for follow-up evaluation if possible. Three graduate students received a week of training in interview skills, ensuring that each interview took 10–15 min to fill out the form. The FJS-12 is an outcome questionnaire that assesses patient awareness of the artificial knee or hip joint during activities of daily living.[9] The HHS is used by a physician or a physiotherapist to study the clinical outcome of hip replacement.[17] VAS is a visual numeric pain rating scale (0–10 scale, no pain [VAS = 0], little to some pain [VAS = 1–3], or moderate to severe pain [VAS 4–10]).[18]

To better compare the recovery effects of the two surgeries, we classified the 12 items in FJS-12 that evaluate different types of gravity center motions into three categories: low-movement group (named as LG included item number 1, 2, 5, 9), middle-movement group (named as MG included item number 3, 4, 6, 8), and high-movement group (named as HG included item number 7, 10, 11, 12). Patients were asked when they were first aware of the biggest improvement and which items were improved. Then patients were asked to recall the scores of HHS and FJS-12 at 2 weeks (stitches removal time and the measures were recorded), 1, 3, 6, and 12 months. The recovery rate was calculated by obtaining the percentage of FJS-12 scores at each time point over the final follow-up, calculation formula was recovery rate = scores at follow-up time point/scores at final follow-up × 100% (the scores were FJS-12 and three categories). The proportion of three categories of scores (LG, MG, HG) in the recovery rate of FJS-12 score, calculation formula was proportion percentage = each category scores/final follow-up scores at follow-up time point × 100%.

Recall bias was evaluated by episodic memory at each follow-up time point (removed the stitches at 2 weeks, the first out-patient follow-up at 1 month, the final regular out-patient follow-up at 3 months, the season changed obviously at 6 months, the anniversary of surgery at 12 months). In addition, recall bias was evaluated by difference analysis between a random sampling of 10% of patients and a total sample at each follow-up time point. The flowchart of the follow-up process is shown in Figure 1.

TABLE 1 Demographics of the DAA and PA groups

Variables	DAA (41)	PA (335)	χ^2 or t	p value
Age (years)	59.48 ± 5.14	65.43 ± 8.51	−2.483*	0.032
Gender (Male/Female)	22/19	157/178	1.576†	0.115
BMI (kg/m^2)	25.18 ± 5.32	27.86 ± 4.17	−2.137*	0.046
BMD	−1.58 ± −0.75	−1.36 ± −0.59	−2.034*	0.093
Level of education				
Unschooled	4	15	2.731†	0.107
Primary school	5	46		
Middle school	21	235		
College	11	39		
Hip disease				
DDH	13	75	2.131†	0.113
ONFH	11	106		
OA	17	154		
CRP (mg/L)	5.82 ± 1.35	6.14 ± 2.14	−2.161*	0.087
Albumin (g/L)	37.49 ± 5.07	39.62 ± 4.88	−0.735*	0.396
D-dimer (mg/L)	0.21 ± 0.25	0.19 ± 0.28	1.246*	0.197
Medical history				
DM	11	26	1.862†	0.168
Hypertension	24	41		
CHD	18	37		
MI	7	11		
DVT	2	5		
Antiplatelet drug (Y/N)	18/23	148/187	2.231†	0.104
General anesthesia (Y/N)	25/16	207/128	1.847†	0.125
Surgery time (min)	106.67 ± 25.13	97.81 ± 31.48	2.124*	0.086
Blood loss	305.64 ± 126.28	350.87 ± 105.63	4.416*	0.075
HHS	88.35 ± 8.73	85.12 ± 9.36	0.723*	0.304
FJS-12	55.17 ± 4.14	53.54 ± 4.92	1.416*	0.275

Abbreviations: BMD, Bone Mineral Density; BMI, Body Mass Index; CCI, Charlson comorbidity index; DAA, Direct anterior approach; DDH, Developmental dysplasia of the hip; OA, Osteoarthritis; PA, Posterior approach; VAS, Visual analog scale.; * t value.; † χ^2 value.

TABLE 2 HHS or FJS-12 scores between the matched and follow-up groups

Variables	Matched group (each of 5)	Follow-up group (376)	t value	p value
FJS-12				
Pre-operation	54.86 ± 4.07	53.88 ± 4.02	0.574	0.213
2 weeks post THA	41.19 ± 3.14	40.22 ± 3.32	0.327	0.306
1 month post THA	46.27 ± 4.91	45.09 ± 5.18	0.402	0.274
3 months post THA	52.36 ± 4.02	51.50 ± 3.86	0.374	0.291
6 months post THA	54.53 ± 4.26	53.51 ± 4.15	0.592	0.208
12 months post THA	55.31 ± 0 3.92	54.48 ± 3.35	0.634	0.185
HSS				
Pre-operation	88.05 ± 8.87	86.94 ± 8.81	0.113	0.193
2 weeks post THA	54.28 ± 6.94	56.37 ± 7.15	−1.362	0.072
1 month post THA	76.18 ± 7.25	72.49 ± 8.07	0.254	0.125
3 months post THA	80.59 ± 8.16	79.37 ± 8.43	0.103	0.181
6 months post THA	85.72 ± 9.43	84.16 ± 10.62	0.124	0.187
12 months post THA	90.48 ± 9.91	88.31 ± 12.15	0.085	0.238

Statistical Analysis

The student's t-test or Wilcoxon rank sum test was used to compare numerical variables between groups, and the chi-square test was used for categorical variables. Pearson correlation analysis was used to assess the correlation between numerical parameters. Multivariate analysis of variance (MANOVA) of repeated measurements was used to compare HHS and FJS-12 results at different time points. Wilcoxon rank-sum test was used to evaluate recall bias between random sampling and the total sample. p values <0.05 were statistically significant. The statistical analyses were performed using SPSS version 17.0.

Results

General Results

A total of 429 THA patients were interviewed, and 33 patients were excluded for the following reasons: rheumatic arthritis (n = 9), previous TKA surgery (n = 7), revision surgery (n = 7), preoperative neurovascular disease (n = 5), and dislocation (n = 5). Eventually, 376 patients finished the follow-up, among which 41 (10.9%) and 335 (89.1%) patients underwent DAA and PA, respectively. Before the surgery, the median VAS was 2 (range 1–3) and CCI was 2 (range 0–4), with no significant difference in VAS ($Z = 1.208$, $p = 0.113$) and CCI ($Z = 1.411$, $p = 0.095$) was found between DAA and PA patients. As shown in Table 1, demographic data analysis revealed a significant age difference ($t = 2.483$, $p = 0.032$) and BMI ($t = 2.137$, $p = 0.046$) between the two groups, while there were no significant differences in sex, operating time, level of education, and blood loss. In addition, no other prosthetic complications or revision surgery were observed in both groups.

FJS-12 Score

The mean preoperative FJS-12 was 54.75 ± 3.38. And negative correlation was found between FJS-12 and BMI ($r = 0.673$, $p = 0.065$), among ages ($r = 1.033$, $p = 0.152$). There was no significant difference in BMI ($F = 1.073$, $p = 0.071$); and it was found that overweight and obese I-grade patients had the highest FJS-12 scores (58.17 ± 4.32 and 59.34 ± 4.86). Moreover, there was no significant difference in FJS-12 between males and females ($t = 1.026$, $p = 0.115$). No significant difference in FJS-12 was found between the random sampling patients and total follow-up groups at each time point (Table 2).

The FJS-12 for the three surgeons at follow-up had no significant difference ($F = 1.411$, $p = 0.103$). The difference in FJS-12 score between the DAA and PA groups was shown in Table 3. The FJS-12 score was significantly higher in the DAA group than the PA group at 2 weeks ($t = 2.075$, $p = 0.042$), 1 month ($t = 4.513$, $p = 0.038$), and 3 months ($t = 3.152$, $p = 0.045$) (Figure 2A). And there was no significant difference at 6 months ($t = 1.113$, $p = 0.139$) and 12 months ($t = 1.032$, $p = 0.152$). After MANOVA of repeated measurements, we found that the FJS-12 score was higher in DAA at 2 weeks ($F = 14.295$, $p < 0.001$), 1 month ($F = 5.637$, $p = 0.021$), and 3 months ($F = 3.264$, $p = 0.045$) after surgery.

The FJS-12 scores for HG were significantly higher after DAA than PA at these time points ($t = 3.225$, $p = 0.022$ at 2 weeks, $t = 3.081$, $p = 0.041$ at 1 month, and $t = 2.783$, $p = 0.046$ at 3 months, Table 4), but no significant difference was found in LG and MG at any other points (Figure 2B). The significant difference in the recovery of FJS-12 score in HG for DAA and PA groups were found at 2 weeks ($t = 3.131$, $p = 0.035$), 1 month ($t = 4.065$, $p = 0.016$), and 3 months ($t = 0.82$, $p = 0.037$). The change in FJS-12 scores observed for HG accounted for 76.38% at 2 weeks, 88.73% at 1 month, 82.69% at 3 months of the change in the DAA group, and 61.82% at 2 weeks, 72.45% at 1 month, and 78.96% at 3 months of the change in the PA group. Awareness of the biggest improvement was first recalled at 1.45 ± 0.34 months in the DAA group and 3.01 ± 0.57 months in the PA group ($t = 2.741$, $p = 0.017$).

TABLE 3 The difference in FJS-12 scores between direct anterior approach (DAA) and posterior approach (PA) group

Time	DAA (41)	PA (335)	*t*	*p* value
2 weeks	42.15 ± 3.36	38.09 ± 3.28	2.075	0.042
1 month	49.06 ± 5.14	41.11 ± 5.21	4.513	0.038
3 months	53.23 ± 4.07	48.09 ± 3.71	3.152	0.045
6 months	55.18 ± 4.01	52.36 ± 4.25	1.113	0.139
12 months	55.27 ± 3.46	53.69 ± 3.24	1.032	0.152

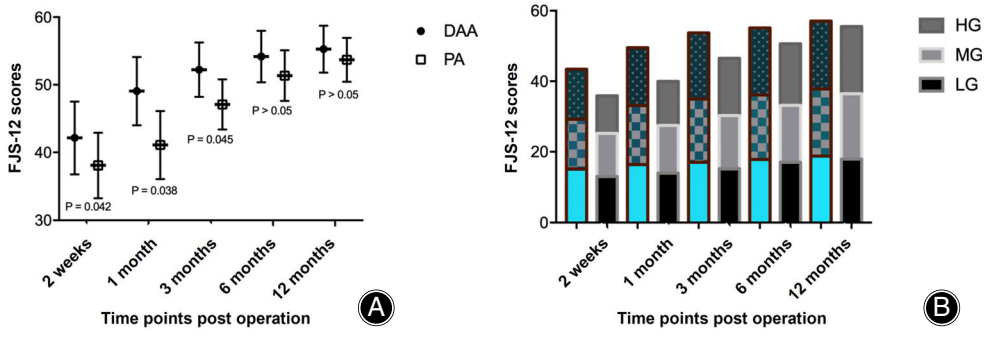

FIGURE 2 FJS-12 scores after THA between DAA and PA. (A) FJS-12 scores were significantly higher in the DAA group than in the PA group at 2 weeks ($p = 0.042$), 1 month ($p = 0.038$), and 3 months ($p = 0.045$). (B) FJS-12 scores for LG, MG, and HG between DAA and PA. FJS-12 scores for HG were significantly higher in the DAA group than in the PA group at 2 weeks ($p = 0.022$), 1 month ($p = 0.041$), and 3 months ($p = 0.046$). FJS-12: Forgotten Joint Score-12. THA, Total hip arthroplasty; DAA, Direct anterior approach; PA, Posterior approach; LG, low-movement group; MG, middle-movement group; HG, high-movement group

TABLE 4 The difference categories of FJS-12 score between direct anterior approach (DAA) and posterior approach (PA) group

Time	DAA (41)	PA (335)	*t*	*p* value
2 weeks				
LG	15.06 ± 3.13	13.27 ± 2.82	2.016	0.098
Recovery	78.31% ± 6.13%	76.31% ± 5.84%	0.241	0.326
MG	14.18 ± 3.09	12.35 ± 3.01	1.784	0.215
Recovery	68.52% ± 5.32%	65.52% ± 5.16%	0.873	0.275
HG	16.18 ± 3.61	12.69 ± 3.02	3.225	0.022
Recovery	60.74% ± 5.07%	55.74% ± 5.02%	3.131	0.035
1 month				
LG	16.37 ± 3.24	14.02 ± 3.15	2.105	0.095
Recovery	85.12% ± 6.46%	83.17% ± 6.15%	0.275	0.317
MG	16.76 ± 3.31	13.46 ± 2.93	2.267	0.082
Recovery	78.25% ± 5.91%	76.24% ± 5.62%	0.653	0.255
HG	19.25 ± 3.83	16.73 ± 3.46	3.081	0.041
Recovery	90.38% ± 6.84%	73.45% ± 5.94%	4.065	0.016
3 months				
LG	17.01 ± 3.33	15.24 ± 3.72	2.114	0.103
Recovery	91.35% ± 6.96%	89.36% ± 6.12%	0.321	0361
MG	17.98 ± 3.47	15.02 ± 3.64	2.352	0.079
Recovery	86.26% ± 6.25%	86.18% ± 6.28%	0.935	0.138
HG	22.04 ± 3.72	19.53 ± 3.75	2.783	0.046
Recovery	93.64% ± 6.88%	88.74% ± 7.12%	3.823	0.037

Moreover, most patients selected item number 11 in FJS-12 (awareness taking a walk/hiking) (45.74% patients [n = 172] in total, 68.29% [n = 28] in DAA, and 42.99% [n = 144] in PA).

HHS and VAS Analysis

There were no significant differences in HHS scores between patients with DAA and PA at follow-up, preoperative or five time-points (2 weeks, 1, 3, 6, 12 months) after surgery ($p > 0.05$). Similarly, there were also no significant differences in VAS scores between patients with DAA and PA ($p > 0.05$). Moreover, there were no significant differences in HHS and VAS scores between randomly sampled patients and total follow-up groups at each time point (Table 2) (each $p > 0.05$).

Discussion

In the present study, we showed that the FJS-12 score of patients who received DAA treatment was better than that of PA ones, with the fastest recovery observed at 1 month (84.05%), lasting for the first 3 months after the operation. Particularly, recovery was primarily observed for advanced high gravity movement (76.38%, 88.73%, and 82.69% at 2 weeks, 1, and 3 months). In other words, DAA was superior to PA for prosthesis adaptability in the first 3 months after THA, leading to a faster recovery for advanced high-gravity movements. Consistently, superior results at 1 or 3 months have been reported in the literature.[1,19]

Prosthesis Awareness and FJS-12

The purpose of hip arthroplasty is to create a pain-free joint with the same range of motion as the native joint, called a "forgotten" joint. The FJS-12 is a questionnaire that assesses a patient's awareness of his/her artificial joint.[13] FJS-12 was found to be better at distinguishing patients with good post-operative outcomes in comparison with The Oxford Hip Score.[20] The FJS-12 score achieved a clinically significant improvement within the first 6-month postoperatively,[21] which was more objective and not affected by the patient's psychological or sleep state.[22]

Influence of BMI on Rehabilitation of THA Patients

Obese patients (BMI ≥ 30 kg/m^2) have been found slow gait speed and limited flexion range of the hip, although it does not impact hip function after THA.[23] A study found a significantly smaller hip range of motion (ROM) of extension and flexion in pre-obese and obese groups.[24] Future THA technology and surgical methods should improve hip flexion capacity, including walking velocity and stride length.[25] Soft tissue restrictions are more important for most movements than bony and prosthetic impingement.[26] BMI was strongly associated with reoperation rates, implant revision or removal, and common complications.[27] BMI was also an important predictor of upright activity and stepping after THA.[28] Although there were significant differences in age and BMI between the two groups and the FJS-12 was higher in younger patients and lower BMI, no significant differences or significant negative correlations in BMI were observed among every 5-year-old age groups. In the present study, we found that rehabilitation would be limited in patients with a low BMI score, although the difference was not statistically significant.

Advantage of DAA for Hip Motion

Hip abductor strength and fatigue have been associated with activity levels.[29] Hip abductor strength was improved in both the lateral approach and the PA after THA, but there was no significant difference between them.[30] Moreover, abductor function was associated with hip stabilization after THA in some surgical approaches.[31] Accordingly, PA provides better functional outcomes regarding gait and abductor muscle strength than the anterolateral approach.[32] It has been reported that the walking speed and step length were reduced in the long term after THA, especially during sagittal hip power generation.[33] Interestingly, different approaches reportedly yield a difference in gait biomechanics postoperatively.[34] Moreover, the sagittal plane hip ROM (peak flexion-peak extension) was associated with HHS scores[35]; however, weaker hip flexion at 2 and 6 weeks in the DAA group was not found in this study, in contrast with the literature.[36]

Advantages of FJS-12 in DAA

In the present study, the FJS-12 score revealed significant differences in the short-term outcome between the DAA and PA groups. The superior recovery of FJS-12 was observed

from 1 to 3 months after the DAA treatment, especially in advanced high-gravity movement. Consistent with our findings, Brismar et al. reported that DAA results in reduced immediate postoperative pain, better hip function, and higher quality of life in the early postoperative period.[37] These patients who underwent DAA also had less pain and shorter hospitalization.[12] Importantly, no complications were reported after DAA,[38] and periprosthetic joint infection after DAA was not considered a significant risk.[39]

Limitation and Strengths

There were some limitations in this study. First, given the retrospective nature of our study, our findings may be affected by recall bias, and the sample size cannot be estimated. Further RCT study will be conducted to confirm our findings. Second, the DAA group was performed much less than PA, for DAA surgery needs the special supine traction device and the practiced operator, and more patients need to be included in further research. Moreover, the present research did not include gait abnormalities or living habits that may affect awareness and gait analysis. Besides, significant heterogeneity surrounded the rehabilitation programs after surgery.

The present study also had some strengths. First, the superiority between DAA and PA was evaluated innovatively from the prosthesis awareness perspective, showing DAA had better prosthesis adaptability in the first 3 months after THA. Second, a thorough analysis was performed by dividing FJS-12 into three categories according to the level of hip activity. Furthermore, our study showed that high-movement gravity center motion was the key point in the early rehabilitation period.

Conclusions

DAA was superior to PA for prosthesis adaptability in the first 3 months after THA (the peak recovery was observed at about 1 month). The hip activity could recover 90.38% 1 month after THA *via* DAA. We found more active rehabilitation in the DAA group in the first month and reflected in high-movement gravity center motions within the first 3 months.

Author Contributions

Dr. Jing Shen and Dr. Ruiqing Ji drafted the original manuscript; Dr. Sai Yao, Dr. Pengfei Ruan, Dr. Zhouwei Zhu, Dr. Xiang Wang, Dr. Huihui Sun, and Dr. Jie Chen performed the review and data collection. Professor Hongfeng Ruan and Professor Weifeng Ji contributed to the conception of the study.

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Disclosure

All named authors have no conflicts of interest to disclose in relation to this article.

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