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Original Article ORTOPAEDICS & TRAUMATOLOGY

The role of arthroplasty surgery experience on successful outcomes in primary total hip arthroplasty surgery

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ABSTRACT

OBJECTIVE: Total hip arthroplasty (THA) is one of the orthopaedic surgeries performed today that yields satisfactory results. The surgeon volume has an important effect on the success of THA and we predict that surgeon-related variables can be brought to the most optimal level with experience.

METHODS: Patients who underwent primary THA surgery between 2015 and 2024 and had at least 1 year of follow-up were included in the study. High volume (HV) in surgeons who performed at least 20 primary THA operations in at least 3 consecutive years. Surgeons with 5 years or more of experience in orthopedics and traumatology were defined as low volume (LV). Acetabular inclination angle, limb length discrepancy, femoral stem malalignment, and hip rotation center conformity according to the Ranawat triangle method were determined from postoperative radiographs.

RESULTS: In the study investigating the relationship between primary THA and surgeon volume, a significant relationship was found between surgical time, hospital stay, dislocation, blood loss, leg length discrepancy and hip rotation center according to Ranawat triangle as surgeon experience increased. No significant relationship was found between the groups in terms of revision surgery, acetabular inclination angle, femoral stem malalignment and periprosthetic infection.

CONCLUSION: As in every field, there is a linear relationship between increasing experience in a surgery or disease group and successful results in orthopedics and traumatology. Complication rates may decrease with the increase in HV surgeons in every field. For this reason; increasing the experience of surgeons in a certain field in orthopedics and traumatology will help them follow new developments in this field.

Keywords: Complication; Ranawat triangle; surgeon volume; total hip arthroplasty.

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Total hip arthroplasty (THA) is one of the orthopedic surgeries performed today that yields satisfactory results. THA is a surgical procedure performed for various disorders of the hip joint in a wide range of age groups. More than 90% of patients who undergo THA report successful pain relief [1]. More than 300,000 THAs are performed each year in the United States [2].

Some factors have been defined in the literature to minimize hospitalization, reduce complication rates and maximize patient satisfaction for such a frequently performed surgery in the USA and the world. These may be patient-related variables such as age, etiology, comorbid diseases, high BMI, ASA score, neuropsychiatric disorders, while there are also implant and sur-

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geon-related factors [3–8]. Implant-related variables include the location of the femoral stem, cemented acetabular or femoral stem, and the material type of the femoral head [9]. Surgeon-related variables include implant placement; acetabular inversion angle, hip rotation center according to Ranawat triangle, femoral stem malalignment, limb lenght discrepancy, surgery time and blood loss during surgery. The effect of providing the most optimal condition among the mentioned factors on increasing the success of THA has been stated in the literature.

We also think that surgeon experience has an important effect on the success of THA and we predict that surgeon-related variables can be brought to the optimal level with experience. Therefore, we designed a study comparing surgeons experienced in arthroplasty with surgeons who perform this operation at a lower level in terms of implant placement (acetabular inversion angle, hip rotation center according to Ranawat triangle, femoral stem malalignment, shortness between both lower extremities), surgery time, and blood loss during surgery. This study aims to add to the literature the effect of increasing case density on surgical success through sub-specialization in surgeries in the field of orthopedics and traumatology.

MATERIALS AND METHODS

Patients who underwent primary THA surgery in our clinic between 2015 and 2024 and had at least 1 year of follow-up were included in the study. Patients were retrospectively screened from the hospital system. Patients' age, gender, ASA score, comorbid diseases, etiologies, surgery duration, hospital stay, dislocation history within 1 year postoperatively, infection history within 1 year postoperatively, and revision history within 1 year postoperatively were documented. Measurements were made and noted according to the degree of acetabular inclination angle, limb length discrepancy, femoral stem malalignment and hip rotation center according to Ranawat triangle method from postoperative radiographs.

During this period, 1078 patients underwent primary THA surgery in our clinic. Of these, 32 had less than 1 year of follow-up, 124 were operated on for developmental hip dysplasia, and 67 were excluded from the study because they did not have a pelvic AP radiograph taken at appropriate standards in the system. A total of 855 patients were included in the study (Fig. 1).

Highlight key points

- Surgeon experience significantly affects perioperative outcomes in primary total hip arthroplasty (THA).
- High-volume surgeons had shorter surgical times, reduced blood loss, and shorter hospital stays compared to low-volume surgeons.
- The incidence of dislocation and limb length discrepancy was significantly lower in patients operated on by high-volume surgeons.
- No significant differences were found between groups in acetabular inclination, femoral stem alignment, or periprosthetic infection rates.
- Increasing arthroplasty experience contributes to improved surgical precision, fewer complications, and enhanced patient satisfaction.

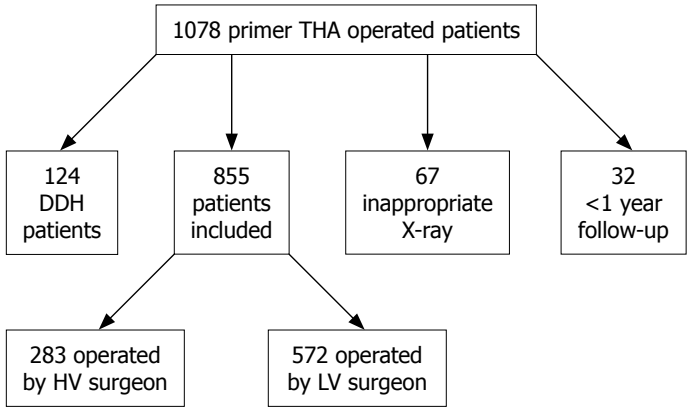


FIGURE 1. Flow chart of sample size.

Patient Exclusion Criteria

Patients with less than 1 year of follow-up, patients whose primary surgery was performed in another center, patients who underwent robotic THA, patients who underwent surgery for developmental hip dysplasia, patients who underwent shortening and revision surgery, patients whose information could not be accessed from the system, and patients whose postoperative and preoperative radiographs were not taken in accordance with radiographic standards were excluded from the study.

Surgeon Volume

Our clinic is a clinic where primary THA operations are performed extensively and the 10-year average is 85.5. In the literature, studies comparing surgeon experience generally compare annual case densities and there is no consensus on the definition of high-volume surgeon. Kreder et al. [10] determined surgical experi-

ence as 10 cases/year in their 1997 study, and Ravi [11] determined it as 30 cases/year in his 2014 study. In our study, we defined high volume (HV) in surgeons who performed at least 20 primary THA operations in at least 3 consecutive years.

It should be emphasized that the definitions of HV and LV surgeons used in this study are study-specific and were determined based on the surgical workflow and case distribution of our institution. Although these thresholds differ from some previously published volume-based classifications, they were designed to reflect meaningful differences in operative exposure and specialization within our clinical setting.

Twenty-nine surgeons who worked in our clinic between 2015 and 2024 and met the inclusion criteria were included in our study. Two of them were high-volume arthroplasty surgeons, while 27 of them had more than 5 years of experience in orthopedics and traumatology and had low THA intensity.

X-ray Evaluation

The acetabular inclination angle is the angle formed by drawing a tangent line from the ischial tuberosities on a standard pelvic anteroposterior (AP) radiograph and drawing it from the widest distal surface of the acetabular cup. The optimal value is between 35° and 55° [12]. In our study, acetabular inclination angle values outside these values were defined as "inappropriate acetabular inclination angle".

The limb length discrepancy can be measured from the orthoroentgenogram or from the pelvic AP radiograph. A tangent line is drawn to the ischial tuberosities. The vertical distance of this line to the trochanter minors of both lower extremities is examined. It has been shown in the literature that lengths greater than 10 mm can cause dislocation, and in our study, inequalities greater than 10 mm were defined as "height difference present" [13].

Femoral stem malalignment is assessed by the femoral stem not being placed parallel to the anatomical axis of the femur on the pelvis AP radiograph. Placement in varus or valgus may disrupt the load distribution balance and cause early loosening/implant failure. Although recent publications indicate that there is no significant difference in terms of mechanical complications in 10-year follow-ups, the view that the femoral stem should be in a neutral position for a successful THA is still current [14].

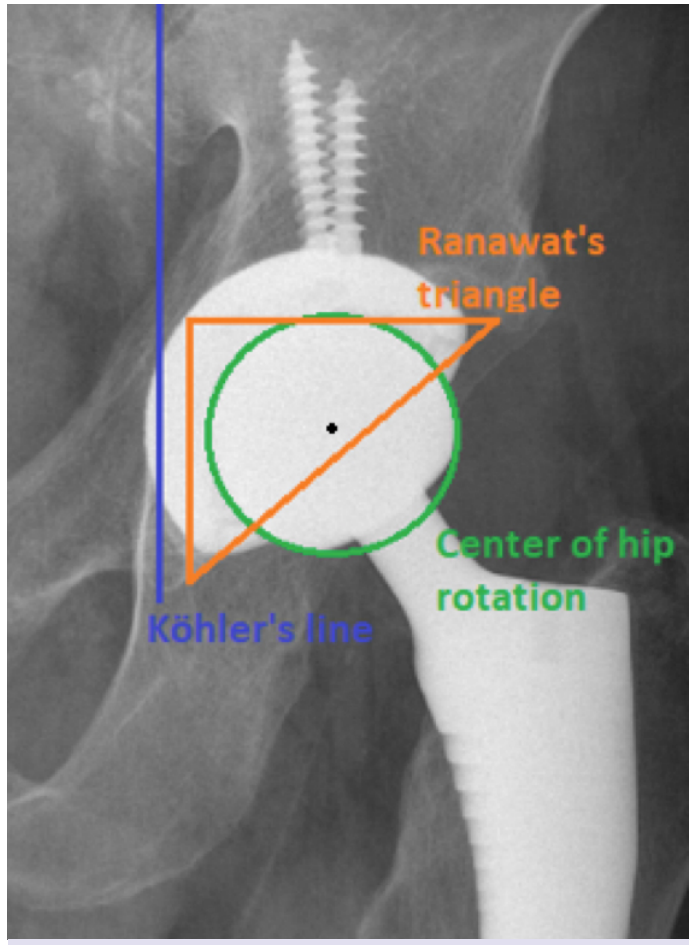


Figure 2. Ranawat triangle and center of hip rotation.

The Ranawat triangle is an isosceles right triangle formed by the intersection of the Shenton Menart line and the line perpendicular to the ground axis passing 5 mm lateral to the Köhler line on the AP radiograph of the pelvis and extending proximally to 20% of the AP length of the pelvis. The midpoint of the hypotenuse of this right triangle defines the hip rotation center [15]. (Fig. 2) In the literature, it has been shown that in cases where the distance of the hip rotation center to the midpoint of the hypotenuse of the Ranawat triangle is less than 5 mm, the generalized offset is more optimal and is associated with successful results [16]. In our study, the distance of the hip rotation center to the midpoint of the hypotenuse of the Ranawat triangle is less than 5 mm and was defined as the "appropriate rotation center".

Ethics committee approval was received from the Umraniye Training and Research Hospital Ethics Committee with document number 63. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Statistical Analysis

Independent sample t-test or Mann-Whitney U test was used to compare numerical parameters between two groups according to their distributions (Shapiro Wilk W test and F-test). Chi-square test was used to compare categorical parameters between two groups. The significance level for all tests was determined as $p<0.05$. Statistical analysis was performed using SPSS Statistics 29.0 (Armonk, New York: IBM Corp.).

RESULTS

Of the 855 patients included in the study, 323 were male and 532 were female. 143 (16.7%) of the patients underwent THA surgery due to trauma. The mean age was 59.2. 160 (18.7%) of the patients were diagnosed with diabetes mellitus, and 334 (39%) had hypertension (Table 1). The number of patients with a history of revision was 41 (4.7%), the number of patients with a history of dislocation was 23 (2.6%), and the number of patients with a history of infection was 21 (2.4%). The mean hospital stay was 4.1 days, the mean postoperative hemogram decrease was 1.58, erythrocyte suspension (ES) replacement was 113 (13.2%), and the mean surgical time was 118.1 minutes. The number of patients with shortening more than 10 mm was 269 (31.4%), the number of patients with inclination degree between 35°-55° was 673 (78.7%), the number of patients with femoral stem malalignment was 15 (1.7%), and the number of patients with appropriate rotation center according to Ranawat triangle method was 666 (77.8%).

While 283 (33%) of the patients in the study were operated by HV surgeons, 572 (66.9%) were operated by LV surgeons. HV surgeons had 1 dislocation history and LV surgeons had 22 dislocations. The p value was seen as <0.05, and it was statistically shown that the HV group had less dislocation history in terms of dislocation history between the two groups. The mean surgical time of HV surgeons was seen as 99.8 min, and the mean surgical time of LV surgeons was seen as 127.1 min. The p value was seen as <0.05, and it was statistically shown that the HV group had a shorter mean surgical time between the two groups. The mean hospital stay of patients of HV surgeons was seen as 3.8 days, and the mean hospital stay of patients of LV surgeons was seen as 4.3 days. The p value was seen as <0.05, and it was proven that the HV group had a shorter hospital stay between the two groups. The mean blood loss of patients of HV surgeons was 1.27 mg/dL, while the mean blood loss of patients of LV surgeons was 1.74 mg/dL. The p value was seen as <0.05, and it was documented that the HV group caused less blood loss in terms of postoperative blood loss between the two groups. When the number of patients who underwent postoperative ES replacement was examined, ES replacement was performed in 21 patients of HV surgeons and 92 patients of LV surgeons. The hypothesis that HV group surgeons needed less ES replacement was found to be statistically significant with a p value of <0.05.

Table 1. Demographics of patients

	n	%
Gender		
Woman	532	62.2
Men	323	37.8
Trauma history	143	16.7
DM	160	18.7
HT	334	39

DM: Diabetes mellitus; HT: Hypertension; n: Sample size.

When HV and LV were compared in terms of the appropriate hip rotation center according to Ranawat triangle, it was seen outside 23 out of 260 patients of HV surgeons and outside 166 out of 406 patients of LV surgeons. The hypothesis that the hip rotation center of the HV group was located appropriate according to Ranawat triangle in more cases was found to be statistically significant as the p value was seen as <0.05.

Nine patients of HV surgeons and 32 patients of LV surgeons required revision. The p value was seen as >0.05 and no statistically significant difference was found between the two groups. 8 patients of HV surgeons and 13 patients of LV surgeons developed a history of infection within 1 year postoperatively. The p value was seen as >0.05 and no statistically significant difference was found between the two groups in terms of infection development.

Femoral stem malalignment was seen in 3 cases in the HV group and 12 cases in the LV group. The p value was seen as >0.05 and no statistically significant difference was found between the two groups. The number of cases with acetabular inclination angle between 35°-55° was seen as 231 in the HV group and 442 in the LV group. The p value was seen as >0.05 and no statistically significant difference was found between the two groups in terms of acetabular inclination angle (Table 2).

Table 2. Statistical analysis of groups in terms of parameters

	High volume	Low volume	Total	p
Acetabular inclination angle				0.143
Between 35°–55°	231	442	473	
<34° and >56°	52	130	182	
Dislocation (n)	1	22	23	<0.05
ES replacement (n)	21	92	113	<0.05
Femoral stem malalignment (n)	3	12	15	0.277
Infection (n)	8	13	21	0.622
Mean blood loss (mg/dL)	1.27	1.74	1.58	<0.05
Mean hospital stay (day)	3.8	4.3	4.1	<0.05
Mean surgery time (min)	99.8	127.1	118.1	<0.05
Ranawat triangle				<0.05
Inside	260	406	666	
Outside	23	166	189	
Revision surgery	9	32	41	0.120
>10 mm limb length discrepancy (n)	26	243	269	<0.05

dL: Deciliter; Min: Minute; mg: Milligram; mm: Millimeter; n: Sample size.

DISCUSSION

In the study investigating the relationship between primary THA and surgeon volume, a significant relationship was found between surgical time, hospital stay, dislocation history, postoperative blood loss, leg length discrepancy and the hip rotation center being appropriate according to Ranawat triangle method as surgeon experience increased.

HV surgeons are more rapid and competent in managing postoperative complications, thus reducing the length of hospital stay for patients. Ong et al. [17] reported that LV surgeons had significantly higher perioperative surgical times than HV surgeons. Our study also found that operative time decreased significantly as surgical volume increased, consistent with the literature. Increased operative time has been shown in the literature to increase complication rates, and HV surgeons are also predicted to have lower complication rates [18].

Bozic et al. [19] showed in their study that as surgeon volume increases, the length of hospital stay and hospital costs decrease. In our study, the average length of hospital stay was 4.3 days in the LV group and 3.8 days in the HV group, and a statistically significant difference was seen in favor of HV.

Siddiqi et al. [20] scanned patients who underwent primary THA between 2012 and 2017 from the American Joint Replacement Registry archive and showed that HV surgeons and hospitals had significantly lower dislocation rates in terms of dislocation history. In our study, the dislocation rate of HV surgeons was found to be lower than that of LV surgeons, and significant results were obtained with the literature.

Lindman et al. [21] reported that patients who underwent THA and total knee arthroplasty by an HV surgeon required a very low rate of transfusion thanks to perioperative modifications. HV surgeons are aware of the estimated bleeding foci in the perioperative phase and can significantly reduce blood loss by cauterizing these foci in advance. In our study, consistent with the literature, blood loss of HV surgeons was found to be statistically significantly lower.

Zampogna et al. [22], in their study, retrospectively examined 800 patients and examined limb length discrepancy in 3 groups as 3 mm, 5 mm and 10 mm. In the majority of patients, the inequality was found to be less than 10 mm with preoperative planning, emphasizing the importance of surgical planning. It is assumed that HV surgeons are more experienced than the LV group in preoperative planning. In line with the literature, in our study, the limb

length discrepancy rate of HV surgeons was found to be significantly lower than that of LV surgeons. Since there is no publication in the literature comparing surgeon experience with limb length discrepancy, we believe that our study will contribute to the literature in this respect.

Ranawat triangle is a measurement technique used to show the location of the femoral head rotation center and is generally used in the literature to adjust the femoral offset in THA cases performed due to developmental hip dysplasia. Chen et al. [23] used Ranawat triangle to determine the acetabular component placement location in patients to whom they applied allograft in their study on THA with severe acetabular defects. They concluded that the use of allograft had a positive effect on limb length discrepancy but did not contribute significantly to the functional Harris score. Fujii et al. [16] found a low correlation between the anatomical hip rotation center and Ranawat triangle method in Japanese people in their study on 123 hips without arthrosis. We believe that our study will bring a new breath to the literature on this subject, as there is no example in the literature comparing surgeon volume with Ranawat triangle. In addition, the integration of the Ranawat triangle as a surgeon volume–related radiographic outcome parameter may offer a novel perspective for future studies evaluating technical accuracy in primary total hip arthroplasty.

In our study, no significant relationship was found between the groups in terms of revision surgery, acetabular inclination angle, femoral stem malalignment and periprosthetic infection.

The literature has reported an inverse relationship between increased surgeon volume and THA complications. However, most studies have shown this relationship at early to mid-term follow-up up to four years postoperatively. However, two studies have not shown the same relationship at 5 and 8 years follow-up [10, 24]. Another study found that LV surgeons had a higher complication rate in the first 18 months postoperatively than in the 12th year postoperatively [25]. In our study, surgeons were compared in terms of revision surgeries when patients had at least 1 year of follow-up and the follow-up ranged from 1 to 10 years. Nine patients in the HV group and 32 in the LV group required revision surgery. No statistically significant difference was observed between the two groups, and these results are not consistent with the literature. The low number of patients requiring revision in our study and the variety of follow-up periods were thought to be the reasons for this situation. In addition, the heterogeneity of the follow-up duration, ranging from 1 to 10 years, may have influenced the observed revision rates. Since revision surgery risk increases over time, shorter follow-up periods may underestimate late revisions, potentially attenuating differences between high- and low-volume surgeons. Therefore, these results should be interpreted with caution, particularly regarding long-term revision outcomes.

It is shown in the literature that there is a significant relationship between the acetabular inclination angle and dislocation rates and that the optimal acetabular inclination angle is between 35°–55° [12]. Suhardi et al. [26] conducted a study showing the relationship between surgical experience and acetabular cup position with patients who underwent computer-assisted and free-hand techniques. No significant difference was found between computer-assisted and free-hand techniques, and a significant relationship was found between the duration of surgical experience and the acetabular cup position. In our study, the groups were examined in two groups as those with and without acetabular inclination angle between 35°–55°. No statistically significant relationship was found between the HV and LV groups, and the results we found were not consistent with the literature. Suhardi et al. [26] evaluated surgical experience according to the years of education between fellow and orthopedics and traumatology resident students in their study. However, in our study, we included physicians who completed their residency training and had at least 5 years of orthopedics and traumatology expertise in our study. We assume that the reason for this discrepancy is due to the methodological differences in terms of surgeon experience between the two studies.

Romanowski et al. [27] compared surgical experience and femoral stem position in hip arthroplasty cases performed using computer-aided navigation systems. No significant relationship was found between surgical experience and femoral stem malalignment, and they stated that computer-aided navigation systems reduced femoral stem malalignment. In our study, no statistically significant difference was found between the HV and LV groups in terms of femoral stem malalignment. It may be considered that femoral stem malalignment should decrease with increasing surgical experience. However; in our study, the number of patients with femoral stem malalignment in both groups was very small, 3 in the HV group and 12 in the LV group, and we predict that the difference is not statistically significant. New studies with a larger sample size are needed on this subject.

Wier et al. [28] compared HV hospitals with LV hospitals in their multicenter study conducted on 605,254 patients who underwent total joint arthroplasty between 2015 and 2021. They showed that the periprosthetic infection rates were lower in HV hospitals. In the same study, the periprosthetic infection rates of LV surgeons in the two groups of hospitals were compared and the infection rate of LV surgeons in the HV hospital was found to be lower than that of LV surgeons in the LV hospital [28]. In our study, no significant relationship was observed between the infection rate of HV surgeons and the infection rate of LV surgeons, and we assume that this difference is due to the preoperative, peroperative and postoperative treatment protocols of HV hospitals. Our study is single-center and sheds light on the literature in terms of showing the infection rates of HV and LV surgeons in the same center.

This study has some limitations due to its retrospective nature. Firstly, the fact that the cases were single-centered is a weakness of the study. The unequal number of HV surgeons and LV surgeons causes imbalance in the groups.

Conclusion

As in every field, there is a linear relationship between increasing experience in a surgery or disease group and successful results in orthopedics and traumatology. Complication rates may decrease with the increase in HV surgeons in every field. For this reason, increasing the experience of surgeons in a certain field in orthopedics and traumatology will help them follow new developments in this field. It will also help increase surgical success and patient satisfaction. Since retrospective studies have certain limitations, prospective studies are needed to investigate the effect of surgeon volume on complications in THA cases.

Ethics Committee Approval: The Health Sciences University Umraniye Training and Research Hospital Ethics Committee granted approval for this study (date: 13.03.2025, number: E-63).

Informed Consent: Written informed consents were obtained from patients.

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