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Novel lateral support system increases stability and reduces angular error in total hip arthroplasty: A case control study

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Ethics Committee Approval
Informed consent was obtained from all individual participants included in the study. The study was approved by the Clinical Research Ethics Committee of Maltepe University (No: 2021 /900/42, Date: 5.01.2021).
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest
No conflict of interest was declared by the authors.

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Abstract

Background/Aim: Intraoperative changes in patient position or other changes that would disrupt the decisive position during preoperative preparation would directly have a negative impact on acetabular cup orientation in patients undergoing total hip arthroplasty. This study aimed to compare the standard support system and a novel lateral support system (Maltepe), which ensures stable lateral decubitus positioning during the perioperative period, in patients undergoing total hip arthroplasty with the posterolateral approach.

Methods: Patients operated in our department for osteoarthritis of the hip between 2012 - 2019 were included in this case-control study retrospectively. 46 and 41 patients were prepared for surgery in lateral decubitus position using the classical (Group 1) and novel (Group 2) lateral support systems, respectively. The groups were compared in terms of demographic characteristics, duration of preparation, anteversion and inclination, and Harris Hip scores.

Results: Mean patient age was 66.89 (7.53). There was no significant difference between the two groups in terms of age (P=0.546), gender (P=1.00), body mass index (P=0.302) and the operative side (P=0.724). Duration of preparation and absolute deviation values from 15 degrees and 45 degrees were significantly better in group 2 compared to group 1 (P<0.01). There was no significant difference between the Harris Hip Scores of two groups.

Conclusion: We demonstrated that the novel support system we developed provided more successful outcomes than the classical system in terms of acetabular cup orientation.

Keywords: Arthroplasty, Hip, Lateral decubitus, Surgical preparation time, Surgical positioning

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Introduction

Osteoarthritis (OA) has become a global health problem due to the increase in elderly population and increased prevalence of obesity, thereby leading to a gradually increasing number of arthroplasties relative to other orthopedic surgeries [1, 2]. Total hip arthroplasty (THA) and total knee arthroplasty (TKA) are the two most common types of arthroplasty, although the prevalence of different arthroplasty procedures exhibit variations throughout the world [3]. Due to its unquestionable ability to restore function and relieve pain, THA has been included among the most successful procedures for end-stage hip arthritis [4]. Although THA is a highly successful surgical procedure, the frequency of joint instability remains as a challenge. Various surgical approaches to the hip joint have been described in attempts to solve this problem [5, 6]. In particular, the direct anterior approach (DAA) is reported to yield low rates of dislocation in the literature [7]. However, recent studies have shown that there is no significant difference in terms of dislocation between DAA and the posterolateral approach (PA), which was claimed to have the highest rate of dislocation, when performed by experienced teams [8]. This indicates that component positioning may in fact be a better determinant of dislocation as compared to surgical approach in THA [9]. In THA performed in lateral decubitus position, determining the femoral component position is relatively easier than determining the position of the acetabular component. Femoral component can be properly aligned according to femoral version and epicondylar axis [10]. However, bone and soft tissue landmarks used for acetabular cup orientation are based on the assumption that the pelvis is maintained in a firm and fixed lateral position during surgery. Therefore, intraoperative changes in patient position or other changes that would disrupt the position during preoperative preparation would directly have a negative impact on acetabular cup orientation [11].

Our hypotheses were as follows: (1) Novel lateral support system can shorten the time to start surgery, (2) since this system provides full stability over the perioperative time, the probability of angular error is reduced. In this study, it was aimed to compare the standard support system with the novel lateral support system (Maltepe), which ensures stable lateral decubitus positioning during the preoperative-intraoperative period in patients undergoing THA with the standard PA.

Materials and methods

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the Clinical Research Ethics Committee of Maltepe University (date: 19/01/2021, no: 2021/900/14). Informed consent was obtained from all individual participants included in the study. According to descriptive statistics (effect size Cohen's d=0.788) in the study by Buğlak et al. [12] sample size of 36 for each group (72 in total) achieves 90% power at the two-sided 0.05 significance level. Sample size was calculated by using two-sample t-test power analysis via PASS 11. (Hintze, J. (2011). PASS 11. NCSS, LLC. Kaysville, Utah, USA. www.ncss.com.).

The patients who underwent THA with the PA in the lateral decubitus position for primary OA of the hip between 2012 and 2019 were retrospectively evaluated. Patients between 55 and 75 years of age, who received surgical treatment with a Kellgren and Lawrence classification grade of 3–4, and attended follow-up examinations for at least 12 months were included in the study. Patients who were lost to follow-up, those who had a history of hip surgery or traumatic dislocation and those who needed revision surgery were excluded.

Eighty-seven patients who fulfilled the aforementioned criteria were included in the analyses. All patients were operated by two surgeons (M and K). While the operations were carried out with classical support from 2012 to the beginning of 2016, this novel system was started to be implemented after 2016 in order to reduce the time and the possibility of angular errors. All patients were prepared for surgery in the lateral decubitus position and PA was used in THA. The surgery was performed by these two surgeons in 46 patients (30 males, 16 females) (i.e., Group 1) using the classical lateral support system (Figure 1A), and by Surgeon K on 41 patients (27 males, 14 females) (i.e. Group 2) using the novel Maltepe support system.

Figure 1: Images of the support units used. A. Classical lateral support system. B. One side was supported with classical support system, while other side was supported by the Maltepe novel support system. C. Maltepe novel support system

In the hip joint surgery, the shape of the surgical lateral support unit (Maltepe support system) that allows the patient to be given a fixed lateral decubitus position by applying to the lower abdomen and the waist, and the appearance of patient application are given in Figure 1B and 1C. In fact, it is a simply designed pillow. Due to its design and stretching feature, it compresses the patient completely into the middle. This pillow consists of 2 pieces and is applied from the front and the back. Its main feature is that it has a stretching capacity like a sponge. Due to its flexibility, this pillow can be used regardless of the patient's height and body weight. The application of this unit is done directly after the patient is anesthetized and is suitable for positioning. First, the patient is turned to the lateral decubitus position deemed appropriate by the surgeon, and then the front pillow is applied to the patient's lower abdomen with the surface facing the patient. Then, the back pillow is applied to the patient's waist region with its surface facing the patient. The pillows applied to the patient from the front and the back are fixed to the side support apparatus of the operating table with their own supports after the final corrections are made in the patient position. Thus, the patient is positioned quickly and fixation is made easily in this position. Since the pillows are made of viscoelastic material, they can be shaped according to the shape of the body, on the other hand, they firmly fix the patient. Thus, owing to its large surface area, it does not cause any problems in the patient's body, but has the potential to reduce angular errors and complications due to full lateral lying and continuity.

Data of the patients in both groups were examined and age, gender, BMI, operative side and duration of preparation for surgery were recorded. Harris Hip Score was used to evaluate the clinical outcomes during postoperative follow-up examinations compared to the preoperative period. In addition, postoperative acetabular cup placement was checked by measuring anteversion and inclination from direct anterior-posterior and lateral radiographs of the pelvis, as described in the study by Seagrave et al [13].

Statistical analysis

All analyses were performed with SPSS v21 (SPSS Inc., Chicago, IL, USA). The Shapiro Wilk test was used for the normality check. Data were expressed with mean (standard deviation; SD) or median (minimum - maximum) values for continuous variables according to the normality of distribution, and with frequency (percentage) values for categorical variables. Normally distributed variables were analyzed with the independent samples t-test. Non-normally distributed variables were analyzed with the Mann–Whitney *U* test. Categorical variables were compared for distribution with Chi-square tests. $P<0.05$ was considered as the threshold for statistical significance.

Results

The study included 87 patients in total. Males comprised 65.22% and 65.85% of the patients in group 1 and 2, respectively. The mean patient age was 67.37 (6.27) years in Group 1, and 66.37 (8.79) years in Group 2. The mean BMI was 25.26 (4.60) and 26.27 (4.41) in Group 1 and Group 2, respectively. Operative side was the right side in 50% of the patients in Group 1 and 44% of the patients in Group 2 (Table 1).

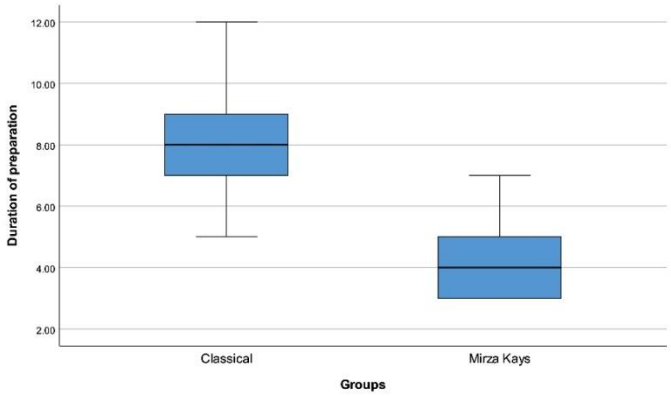
Table 1: Summary of the variables with regard to groups

	Groups		
	Classical (n=46)	Maltepe (n=41)	*P*-value
Age	67.37 (6.27)	66.37 (8.79)	0.546
Gender			
Female	16 (34.78%)	14 (34.15%)	1.000
Male	30 (65.22%)	27 (65.85%)	
Body mass index	25.26 (4.60)	26.27 (4.41)	0.302
Underweight	4 (8.70%)	2 (4.88%)	0.528
Normal	20 (43.48%)	13 (31.71%)	
Overweight	14 (30.43%)	17 (41.46%)	
Obese	8 (17.39%)	9 (21.95%)	
Side			
Right	23 (50.00%)	18 (43.90%)	0.724
Left	23 (50.00%)	23 (56.10%)	
Duration of preparation	8 (5 - 12)	4 (3 - 7)	<0.001
Underweight	9.5 (9 - 12)	3.5 (3 - 4)	0.060
Normal	8 (5 - 9)	4 (3 - 5)	<0.001
Overweight	7.5 (6 - 9)	4 (3 - 5)	<0.001
Obese	10.5 (9 - 12)	6 (5 - 7)	<0.001
Anteversion angle	20 (7 - 32)	16 (12 - 20)	0.029
< 15 degrees	13 (28.26%)	8 (19.51%)	0.247
15 degrees	3 (6.52%)	7 (17.07%)	
> 15 degrees	30 (65.22%)	26 (63.41%)	
Absolute deviation from 15 degrees	6 (0 - 17)	1 (0 - 5)	<0.001
Inclination angle	45.5 (19 - 70)	45 (30 - 54)	0.762
< 45 degrees	17 (36.96%)	12 (29.27%)	0.375
45 degrees	6 (13.04%)	10 (24.39%)	
> 45 degrees	23 (50.00%)	19 (46.34%)	
Absolute deviation from 45 degrees	11 (0 - 26)	2 (0 - 15)	<0.001
Harris hip score	67.5 (60 - 88)	70 (56 - 90)	0.534

Data are given as mean (standard deviation) or median (minimum - maximum) for continuous variables according to normality of distribution, and as frequency (percentage) for categorical variables

The mean duration of preparation for surgery in the operating room was 8 minutes in Group 1 and 4 minutes in Group 2, the difference was found to be statistically significant ($P<0.001$, Table 1, Figure 2). Considering the duration of preparation for surgery in the operating room according to BMI, there was a statistically significant difference between the two groups in normal-weight, overweight and obese patients ($P<0.001$) but no significant difference in underweight patients ($P>0.05$, Table 1). Dislocation was detected in 4 cases in group 1 and in 1 case in group 2 ($P=0.201$).

Figure 2: Duration of preparation with regard to groups



Comparison of the two groups in terms of acetabular cup orientation showed no statistically significant difference between the groups in terms of anteversion and inclination ($p>0.05$, Table 1, Figure 3 and 4). On the other hand, there was a statistically significant difference in terms of absolute deviation from 15 degrees of anteversion and absolute deviation from 45 degrees of inclination of the acetabular cup ($P<0.001$, Table 1).

Comparison of the two groups in terms of Harris Hip Scores did not show statistically significant difference at postoperative month 12 (Group 1: 67.5 points vs. Group 2: 70 points; $P=0.534$, Table 1).

Figure 3: Absolute deviation from ideal anteversion angle with regard to groups

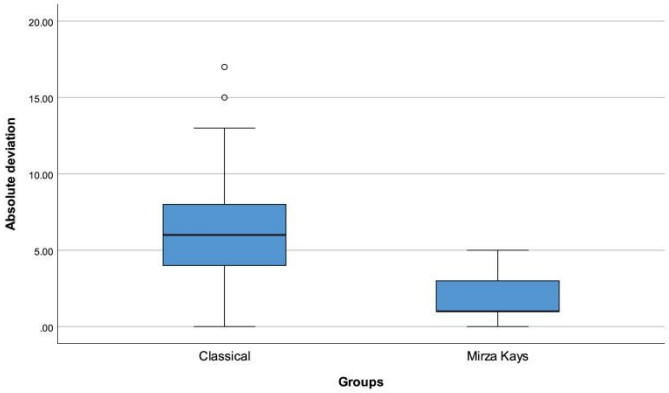
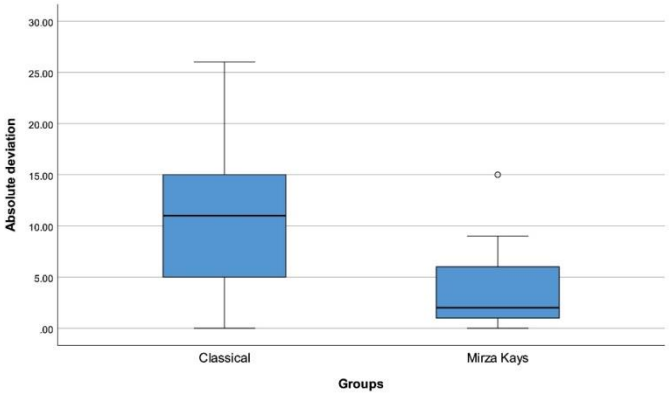


Figure 4: Absolute deviation from ideal inclination angle with regard to groups



Discussion

The most important finding of this study is that the novel (Maltepe) lateral support system significantly shortens the duration of preparation for surgery. In addition, it was determined that the better support provided by this system reduced the rate of angular error caused by the surgeon in acetabular cup orientation in patients undergoing THA in the lateral decubitus position via PA.

In THA, a malpositioned acetabular component constitutes a modifiable risk factor for component impingement, wear of the bearing surface and postoperative instability [9, 14-16]. Implant stability and wear can be optimized by placing the cup within "safe zone" parameters [9, 14-17]. According to a retrospective case series by Lewinnek et al. [9], the safe zone is defined as 15 +/- 10° anteversion and 40 +/- 10° inclination. However, the incidence of malpositioning remains high. The known risk factors for malpositioning consist of obesity, low experience of the surgeon and the use of minimally invasive approaches [18]. In addition, it was reported that intraoperative changes in pelvic position could lead to malpositioning of the acetabular cup [11]. In this study, we showed that more successful outcomes could be obtained by using our novel lateral support system that rapidly provides a more stable lateral decubitus position and appears to enable better acetabular cup positioning.

It was reported that high anteversion could lead to a decreased risk of dislocation [19]. In this study, we could achieve optimal anteversion and inclination angles in most of our patients with the novel lateral support system we developed.

In our study, this difference was not statistically significant, although the frequency of dislocation was lower in the cases in which the novel system was applied. This may be due to the small number of patients. We thought that with the implementation of this system, better support was provided and this reduced the anteversion error. Consistent with this idea, Fujishiro et al. reported that combined anteversion greater than normal limits after THA increased the frequency of anterior dislocation, while a combined anteversion less than normal limits increased the frequency of posterior dislocation [20]. In addition, it has been reported in various studies that dislocation develops between 1% and 4% after THA, and that the developing dislocation is due to the inability to provide anteversion within optimal limits [20-22].

To the best of our knowledge, there are no studies in the literature elaborating proper patient positioning for surgery during THA performed with the PA. Existing studies generally focus on anesthesia and operational time, and report highly varying results [23]. In this study, duration of patient positioning was compared using two different lateral support systems, which have not been previously discussed in the literature, and it was found that the system we developed provided a significantly shorter duration of patient preparation. In this respect, our study is the first in the literature.

This study had some limitations. First of all, the study was retrospective. Second, follow-up duration was short, although treatment groups had comparable characteristics. Third, factors (age, gender, BMI etc.) that could affect treatment results could not be evaluated in depth due to the small sample size.

Conclusion

Acetabular cup orientation is directly associated with dislocation in THA performed with the PA, wherein proper patient preparation in lateral decubitus position is important for achieving successful outcomes. Here, we showed that more successful THA outcomes could be obtained with the use of the novel lateral support system compared to the classical support system, especially with regard to its positive effects on acetabular cup orientation.

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