Assessment of Cup Placement Impact on Functional Outcomes in Total Hip Replacement: A Retrospective Analysis of 20 Patients

Akshay J Kumar[1], Yeshwanth Subash[1]

[1]Department of Orthopaedics, Saveetha Medical College & Hospital, Saveetha Institute of Medical and Technical Sciences (SIMATS), Thandalam, Chennai – 602 105, Tamil Nadu, India.

KEYWORDS

Cup Position, Inclination, Anteversion, Thr

ABSTRACT

Introduction: Total hip replacement surgery is gaining popularity as a treatment for hip disorders, replacing alternative treatments like excisional arthroplasty, osteotomy, arthrodesis, and hemiarthroplasty. This research aims to evaluate the effect of the acetabular cup on functional outcomes, particularly in younger patients with hip arthritis and femur neck fractures.**Materials And Methods:**This study aimed to evaluate the placement of the acetabular cup and its association with functional outcomes in total hip replacement (THR). 20 patients were randomly selected from the MRD department and underwent pelvic CT scans postoperatively. Functional results have been analyzed using the Harris Hip Score. The acceptable cup version range was 15 ± 10 degrees, and patients outside this range were closely examined for rotational movements**. Results:** A study of 20 patients with a neck or femur fracture found that 11 patients had a right knee injury, while 9 had a left knee injury. After a year postoperatively, 18 patients reported no pain, while 2 had mild pain. Functional assessment depicted better outcomes in 17 patients, good outcomes in 2 patients, and fair outcomes in 1 patient. Radiological analysis revealed a mean cup version of 17.77 degrees, with complications including one dislocation and three limb length discrepancies. None of the patients developed an infection.**Conclusion:**The study found that 90% of patients had excellent functional outcomes, with only 10% exhibiting excessive anteversion. CT scan-based measurements of cup placement provided reliable predictions, consistent with intraoperative assessment of cup positioning.

1. Introduction

For those afflicted with debilitating hip arthritis, total hip arthroplasty (THA), sometimes called the "Operation of the Century," remains a game-changing therapy. [1] The patient's dislocation, abductor muscle strength, gait, and success of the hip arthroplasty procedure are all impacted by the proper positioning of the acetabular cup. Duration of limb movement, Injury sustained Issues with loosening and cup failure, noise production, range of motion, and wear [2,3].

A lot depends on where the implants are placed when you have total hip arthroplasty. Problems with the placement of the implant, such as the neck pressing on the cup liner, can lead to loosening, polyethylene wear, dislocation, and reduced mobility. For this reason, impingement prevention and long-term implant stability depend on precise implant placement. [4]

Variables such as the depth and mediolateral location describe the acetabular component's positioning. Positioning at an angle, which encompasses tilt and version, as well as height or superior/inferior positioning.

To determine the cup's inclination, draw two lines: one parallel to the ground (a line through the ischial tuberosities) and another over the cup's rim; the angle formed by these two lines is the inclination.

The best depth for placing the cup is so that it rests against the illio ischial line. The optimal placement of the underside of the cup is at the teardrop, however, you can tell the correct height by looking at where it sits. For reference, you can look at the side that is opposite from you. The joint reaction force is influenced by the depth or mediolateral positioning of the body's lever arms and abductor mechanism. This, in turn, causes an offset reduction, which can lead to reduced range of motion, increased risk of dislocation, impaired gait, and faster wear on the bearings. The joint reaction force, JRF = BWxB-AbxA, is reduced when the acetabular cup is medialized. However, this medialization can decrease the worldwide offset, which is the sum of the femoral offset as well as the acetabular offset. The femoral offset is the perpendicular distance from the rotation center of the femur head to a central axis of the femur shaft, and the acetabular offset is the distance from the center of rotation of

the femoral head to the inner wall of the quadrilateral plate or true floor. A stem with an offset larger than the femur's natural offset is necessary because medialization decreases the acetabular contribution to global offset.

One potential drawback of medialization is that it could Limitation of hip flexion, The likelihood of bone impingement increasing, particularly in cases when osteophytes are left untreated, and Failure to reestablish global offset increases the risk of microseparation, which in turn accelerates wear. In the case of Hard on Hard bearings in particular, Revision surgery may be affected by medial bone loss. As a result of non-anatomical placement, it may alter proprioception and alter the working length of the muscles. These ideas informed the introduction of the anatomical cup placement, which has benefits in impingement (Imp), range of motion (ROM), cortical rim press fit (CRP), and medial bone stock maintenance. Whereas the length of the limbs, the level of muscular activity and JRF, and the amount of available bone stock to support the cup could be affected by a change in the cup's height.

A disruption in gait would be the clinical manifestation. The combination of neurological symptoms, low back discomfort, and a resulting hip instability. Revision surgery may be necessary if the cup is positioned too low since this could cause the limb to extend. A larger COR raises the likelihood of early wear, aseptic loosening, and implant failure, and it also generates a higher JRF.

The cup's inclination is its orientation with respect to the coronal plane. An acetabular cup should be angled 30–50 degrees abducted for optimal alignment. If the cup is too much out of alignment, it reduces the surface area of contact along the cup's superior dome, which increases the wear rate due to increased contact forces. Edge loading describes this behavior. Reduced range of motion due to an inadequate angle increases the chance of impingement during hip abduction, however, this is less of an issue than when the cup is positioned vertically.

Cup orientation regarding the sagittal plane is known as the version.

The version refers to the cup's orientation regarding the sagittal plane. The zones most often used as safe zones for acetabular cup placement were reported by Lewinnek et al. [5]

In a recent study with 1,823 THAs, Callanan et al. confirmed what Lewinnek had previously found: the best safe cup placement is within 30-45 degrees. [6]

In order to prevent impingement and mimic the natural range of motion of the hip, the optimal acetabular version should be between a 5–25-degree safe zone. A postoperative cross-leg x-ray can evaluate this when in a neutral position, the cup's face is perpendicular to the sagittal plane. With an anteverted cup, your hips will be more adducted because the cup is facing somewhat forward. When the cup is retroverted, it faces backward, which increases abduction and decreases adduction because it presses on the rim. Our Study is done to analyze the cup placement and the functional results in Total hip Replacement Surgeries.

2. Methodology

Retrospective research has been done among 20 cases who had come to Saveetha Medical College between June 2022 to June 2023, who had undergoneTHR who were between the ages of 25 - and 60years,for different causative factors, patients who had Fracture neck of the Femur,Avascular neck of femur, non-union neck of femur. Secondary OA of the hip was included in the study. This research was done at the time of my training period.

To analyze the acetabular cup placement as well as functional results in THR, patients were randomly selected from the MRD department who had cooperated with our research without any drops at Saveetha Medical College and hospitals. CT examinations of the acetabular cup were taken, and the patients were assessed functionally with Harris hip score the corresponding scores were noted. Phones were placed to patients to remind them to come to the ortho OPD. The purpose of the research was to evaluate the functional outcome and post-operative acetabular cup positioning of total hip replacements performed for different indications. All the patients underwent assessment postoperatively with a CT

scan of the pelvis for cup version and inclination. Utilizing the Modified MURRAY approach, the version of the acetabular cup and inclination were measured. The cup version's acceptable range was 15 ± 10. We assessed each of our patients to see if they fell into this range of cup variations. Patients outside of this range underwent extra examination, with a focus on rotational movements.

In order toevaluate the functional result—which was based on Harris's hip score at three weeks, one month, three months, and six months—all of these patients also underwent clinical examination. The collected data was compared, compiled, and examined in the chosen patients. IBM SPSS Version 22 was utilized for the analysis of gathered data. Based on SPSS statistics, 0 was performed, and a statistically significant l P value of 0.005 was discovered.

3. Result and Discussion

In our study which comprised 20 Patients 13 were males and 7 were females **[Graph 1**], In 11 patients their right knee has been impacted whereas in 11 patients their left knee has been impacted [**Table 1**]. 8 Patients suffered from Neck of Femur Fracture,4 Patients had the non-union neck of femur,4 had the avascular head of the femur and 4 had secondary osteoarthritis of hip [**Graph 2**].On Examining the patients at 1-year postoperatively,18 patients had No Pain,2 had mild pain[**Graph 4]**19 Patients presented with no limp whereas 1 patient had a limp[**Table 2],**Functional Assessment was performed using Harris Hip Score,17 Patients had excellent outcome,2 Had Good, and 1 patient had fair outcome[**Table 3**],None of the patients had flexion contractures None of the patients needed support to walk .3 patients had limb length discrepancy of< 2cm[**Graph 3**]. On radiological Analysis the mean cup version was found to be 17.77, The mean cup inclination was found to be the mean functional outcome for flexion was 97.5 degrees, the mean extension was 14.5 degrees, the Mean abduction was 13.1 degrees, the Mean adduction was 21.8 degrees, mean internal rotation was 13.0 degrees,mean external rotation was 26.5 degrees. [**Table 4**]. COMPLICATIONS: One of our cases of dislocation with related sciatic nerve palsy was brought on by a retroverted acetabular cup, which was fixed with revision total hip replacement. The patient's nerve palsy had now healed, and their functional outcome was good. 2 Limb length discrepancy: after THR, the three instances of limb length discrepancy <2.5 cms were resolved. 3. In our study, no patient experienced an infection as a side effect.

DISCUSSION

In our study,an overall number of twenty cases who had undergone Total hip arthroplasty which was performed for various causative factors turned out for follow-up for at least 6 months upto a period of 2 years. The patients were evaluated by us functionally and radiologically.The patients' functional outcomes were analyzed statistically using the Modified Harris Hip Score in order to identify any noteworthy variations after the cup and stem positions were placed.Acetabular inclination and cup anteversion measures were found to be significant indicators of patient-reported outcomes following primary THR, according to our study. The literature and studies that focus on the absolute and relative positions of the acetabular component and how they impact the functional results after total hip replacements are limited. Where exactly the acetabular component should be positioned is a topic of heated controversy. The rates of dislocation continue to form the basis of the positions articulated in the literature.A major and unfavorable consequence of total hip arthroplasty is hip dislocation. The surgeon has little control over the patient's risk of postoperative dislocation, which is influenced by a number of patient-related variables such as neurological problems and previous procedures. One way surgeons might reduce this risk is by optimizing the acetabular component's orientation. Impingement, Dislocations.A number of surgeons have pinpointed specific postures that lessen the possibility of hip dislocation while also increasing stability.

Using data from 300 total hip arthroplasties (THAs) with a 3% dislocation incidence, Lewinnek and colleagues determined the anatomic safe zone for acetabular component placement, for example. Their exact measurements showed that there was a correlation between anterior dislocations and higher anteversion of the acetabular component. The researchers established a safe range for the acetabular abduction inclination angle (45° ± 10°) and anteversion (15° ± 10°), which reduced the dislocation rate

to 1.5% when the cup was put within this range, to 6.1% when it was placed outside.

[5]. Consistent with Lewinneks's findings, Cllanan et.al. conducted a comparable study on 1823 THA patients and concluded that the optimal range for acetabular cup inclination is 30-45 degrees. [6].

Following an analysis of 441 posteriorly executed THAs with a dislocation rate of 1.14 percent, McCollum and Gray established a safe range for the acetabular component position. They suggested anteversion and abduction angles of 20–40° and 30–50°, respectively, for the cups to avoid impingement and dislocation. The inclination ranges from 35 to 55 degrees and the anteversion from 5 to 25 degrees, according to Biedermann et al. (2005), Grammatopoulos et al. (2015), and Danoff et al. (2016).

On the other hand, Grammatopoulos et al. (2015) found a range of 27 to 57 degrees and -3 to 27 degrees of anteversion. According to Garcia-Rey and Garcia-Cimbrelo (2016), there are two "safe windows": (1) between 35 and 50 degrees of inclination and 5 to 25 degrees of anteversion, and (2) between 35 and 50 degrees of inclination and 15 to 25 degrees of tilt. [7-10]

Another Study conducted by Dr. Rohan Krishnan, et. al. conducted a study among 30 patients who underwent THR and it was found that the results were outstanding for 43.33 percent of patients, good for 36.66 percent, fair for 6.66 percent, and bad for 13.33 percent comparing it to our study which consisted of twenty patients in which 85 percent had excellent outcome,10 percent had a good outcome and 5 percent had a fair outcome.

In their investigation, it was found that the average CT anteversion was 15.3 degrees. 29 out of 30 patients had an anteversion that was outside the safe zone. The retroverted cup was present in just one patient. When compared to our study the Ct anteversion angle was found to be 17.77 degrees. One patient required revision was a posterior hip dislocation caused by a retroverted cup. In our study 2 patients had excessive retroversion of the cup placement out of which one patient had posterior dislocation of the hip for which he underwent Revision THR following which the functional outcome was good, The other patient however had no dislocation during follow-up at one and half years.

In Dr Rohan Krishnan et al's study,The average CT inclination angle was 42.7 degrees. At least 28 of the 30 patients' inclination angles were within the acceptable range. The lack of effect on functional results in their study was due to the fact that just two patients had an inclination angle of more than fifty degrees. In our study the average inclination angle was 35 Degrees Research on hip dislocation after total hip replacement by Toshinori Masaoka, Kengo Yamamoto, Takaaki Shishido, and Yoichi Katori found that the direction of the acetabular cup was more important in deciding the rate of dislocation and maintaining hip joint stability [11]

Conditions like Morel-Lavelle lesions and open fractures enhance the likelihood of infection. The implant can be removed when the hip has fused, but if the infection happens early on, hardware preservation can be used to keep the hip stable until then. It is necessary to remove the hardware in the event that infection is detected later on. Cultures must be sent and kept for a long time in all cases of infection, and medicines specific to the culture must be given for a long time as well. Typically, an empirical treatment of six weeks is employed before that [12,13,14].

Both cup and stem anteversion impact impingement, which can cause dislocation or discomfort. Changing these settings influences the patterns of impingement during different hip motions. For the purpose of reducing impingement, it is advised to use a cup inclination ranging from 45° to 55°. The ideal combined anteversion angle is determined by the acetabular abduction angle. As a clinical test for impingement, evaluating discomfort during particular hip motions is essential. When testing for anterior impingement, the patient is asked to flex, abduct, and rotate internally, whereas when testing for posterior impingement, the patient is asked to hyperextend, abduct, and rotate externally. Pain due to impingement is indicated by positive test findings. Optimal cup location may be estimated using several formulae proposed in studies, which take anteversion and inclination into account. The lack of clinical validation of mathematical models means

that clinical advice might not take femoral anteversion, neck/shaft angle, or surgical approach into full consideration. Impingement, and especially cup-neck impingement, can compromise hip stability and lead to dislocations. Within a safe range of motion, the ideal placement of the cup is to avoid instability and impingement. A recommended "safe zone" to prevent dislocations is a cup inclination of 40° ± 10° and an anteversion of 15° ± 10°.

Clinical tests for impingement were negative in our study's patients, suggesting that mechanical obstruction did not cause any discomfort during the subjects' maximal hip flexion andextension.

4. Conclusion and future scope

Total hip arthroplasty (THA) is pivotal for hip arthritis patients, with acetabular cup positioning significantly impacting outcomes. Our study on 20 THR patients showed promising results, with most experiencing excellent functional outcomes and minimal complications. Radiological analysis aligned with established optimal cup placement angles, reducing risks of dislocation and impingement. Clinical examination revealed satisfactory hip stability. Precise cup placement is crucial for successful THA, necessitating further research for enhanced outcomes.

Declarations

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