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CT Based Study of Version of the Acetabular Cup after Total Hip Arthroplasty and its Correlation with the Functional Outcome

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ABSTRACT

Purpose: To correlate the version of the acetabular implant after total hip arthroplasty with the functional outcome and to assess the unassisted manual positioning of the acetabular cup.
Method: A prospective study of 46 adult hips without acetabular defects, treated with first time THA between July 2018 to November 2020. We aimed to find the cup's angle of version using a CT scan post-operatively and to correlate it with the functional outcome. We also assessed the unassisted manual positioning of the cup. The Harris hip score was used to evaluate the functional outcome of patients.
Results: 90% of the acetabular implants were in the acceptable range of version. Among the rest, one episode of dislocation occurred and a few cases had decreased range of motion. However, 97.8% (45 patients) of our study population had an excellent functional outcome.
Conclusion: The CT scan is a more accurate measurement of the acetabular cup version and shows a good outcome of our unassisted manual cup positioning.

Key words: Anteversion acetabular cup, Total hip replacement

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INTRODUCTION

Total hip replacement is a surgical procedure in which, the femoral head and acetabulum of a pathological hip is substituted by prosthetic components. Currently, THRs have become one of the most commonly done reconstructive hip procedures for various hip pathologies. Due to the successful accomplishment of this technique, it is known as the "Operation of the Century"[1].

Even in the presence of surgical techniques like arthrodesis, osteotomies, excisional arthroplasties, hemiarthroplasties for hip pathologies, providing a painless, stable hip is a demanding challenge for an orthopaedist.
THRs have overcome many challenges that were encountered with the other procedures. It is performed on osteoarthritic hips (OA), inflammatory arthritis of hip, AVN(avascular necrosis) of femoral head, acute femoral neck fracture in the active elderly, failed hip procedures and dysplasia's of the hip.

In previous literature, aspects such as the acetabular implant's version, inclination, depth, the femoral implant's version, the neck shaft angle, surgical approach and patient factors affect the success of the surgery. Post-operatively the patient may have complications such as pain, deformity, increased dislocation rates, decreased range of movements, and increased wear of the implants. Among the various factors that affect the outcome, the acetabular cup position, in both the sagittal plane, is prime.

The normal acetabulum is anteverted and ranges between 9-320. The recommended version after total hip arthroplasties is 5-250. Intra-operatively the cup is tried to be placed within the recommended ranges of Anteversion. Post-operative valuation of the cup position wills critic the intra-operative manual unassisted manual placement of the component.

MATERIALS AND METHODS

In 1993, Murray described 3 ways to quantify angular position of the acetabular cup, anatomical, operative and radiographical. Operatively, the anteversion is calculated as the angle between acetabular axis and the longitudinal axis of the patient in the sagittal plane. Radiographically, acetabular anteversion is the angle between the coronal plane and the acetabular axis through a lateral view. Measurements through a CT scan have a higher reliability and accuracy compared to other methods of measurements. We use a modified Murray's method to

assess the anteversion of the acetabular cup on an axial CT scan section.

In the evaluation of the functional outcome, the Harris hip score and the Charnley modification are commonly utilized [2,3]. The HHS is a clinician-based scoring tool that doesn't require time or specialized training [3]. It has a high reliability and validity, being tried against Short Form-36 and the Western Ontario and McMaster Universities Osteoarthritis Index. It has 10 scores, including pain, deformities, functioning and ROM (range of movement), which are later combined. The maximum score is 100. The score outcome is graded as poor (<70), fair (70-79), good (80-89) and excellent (90-100).

Ours is a prospective study of 46 hips between July 2018 to November 2020 conducted at our hospital. We included all adult hip with a closed physis who underwent THA(both cemented and uncemented) for the first time. We excluded all patients with previous history of hip surgery or any acetabular defects. Initially our study population was 62 hips, among them, 13 were not compactable with our inclusion criteria and were hence excluded. 1 patient failed comply with our follow up protocol and 2 patients passed away due to unrelated causes reducing the final study population to 46 hips.

All operations were done by a single primary surgeon, through the posterior approach to the hip. The patients were followed up regularly for a minimum of 6 months, up to 2 years. CT scans of the operated hips were taken during follow-ups. The DICOM file was kept and used to assess the implants version. At follow-ups, functional outcome was evaluated on the basis of the HHS.

Taking axial cuts from the CT, version of the acetabular component was calculated using a modified Murray's method for each patient. Acceptable values were taken as 5-250.

To determine the version, we defined a trans-axial plane perpendicular to the coronal plane at the level of the acetabular cup. Anteversion was measured as the angle between the acetabular cup axis and the Trans pelvic plane. The patients were scored on each follow-up visit. The final score taken on the last clinical visit was used. Each patient was assessed based on the divisions of the questionnaire. The data was accumulated and totalled to get the final HHS which was later graded into excellent, good, fair and poor (Figure 1).

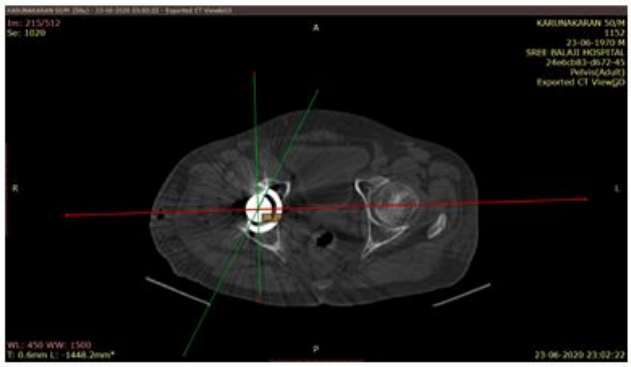

Figure 1: Trans axial plane.

RESULTS AND ANALYSIS

About 90% of our subjects had no limb length discrepancies. None of our other patients had any significant discrepancies. None of our patients had any flexion contractures, fixed abduction or fixed internal rotation (Table 1).

Table 1: Limb length discrepancies.

Limb Length discrepancies	No. of cases
Nil	41
<3.2 cm	5
>3.2 cm	0

A majority of 35 cases had a range-of-motion in the 211-3000 category. The others were in the range of 161-2100. None of our patients had any flexion contracture (Table 2).

Table 2: Range of motion.

Range of motion	No. of cases
211-300	35
161-210	11
101-160	0
61-100	0
31-60	0
0-30	0

Almost all our patients had an excellent score on the Harris Hip Score grading system. Only one patient graded as good. The majority of the cups were placed between 5-150 of anteversion. 4 cases had excessive anteversion and 1 case had a decreased angle of version. None of the cases were in retroversion.

We had one case of dislocation reduced under GA with no further episodes. One patient had no hip internal rotation after the surgery. 4 patients had decreased range of movements but were not affected functionally. None of the patients had significant limb length discrepancies (>3.2cm). None of our patients had any loosening of the implant or developed any infections (Table 3).

Table 3: Version.

Version	No. of cases
0.1-5	1
5.1-10	13
10.1-15	14
15.1-20	3
20.1-25	11
25.1-30	1
35.1-40	3

DISCUSSSION

Determining the optimal placement angle for the acetabular component in THA can be challenging. The placement depends on the version, inclination, depth and height. The aim is to achieve stability and normal range of movement. When the implants range of movement matches the native hip movement, impingement will be absent. Version of the cup is the implant orientation in the sagittal plane and inclination is the orientation in the coronal plane. The normal human acetabulum is slightly anteverted which enables more adduction. Retroversion of the cup can lead to impingement. Harris et al recommended an anteversion of 20° [3]. Harkess suggested an anteversion of 15(±5)0 [4]. McCollum et al determined the safest range for cup placement was 20°-40° of Anteversion [5]. Lewinnek et al. recommended the safe zone as between an inclination of 15°(±10°) [6]. In our study the average acetabular cup anteversion was found to be 15.40. Pedersen showed that a placement of less than 40° abduction and less than 10° anteversion achieves optimal range-of-motion [7,8]. Following our study, 4 patients had excessive inclination, the range of movements were decreased on the operated hip.

Biedermann et al. showed that slight variations in cup positioning can increase rates of dislocation [9]. Dorr et al has concluded the most common cause for recurrent dislocations after THA was incorrect anteversion of the acetabular cup [10]. Ali Khan et al showed that in patients who suffered dislocations, the cup position was either too anteverted (>15.0) or too vertical (>500) [11]. One of our cases in whom the anteversion was less than 50, had an episode of dislocation. Once relocated, no further episodes of dislocation were seen. Another 2 cases had a higher angle of anteversion, which caused decreased range of motion of the hip. McCarthy et al concluded that impingement occurrence varied in individuals and certain activities reduces the safe zone [12].

Although hip dislocations may occur sans impingement, it is the most often cause. An optimal acetabular component position is crucial in providing an impingement free range of motion, preventing dislocation and providing stability. Although controversial, from a clinical view point we consider the safe zone as between 5-25° of inclination. Many of these studies don't take into account the femoral anteversion, neck-shaft relation, restoration of hip biomechanics, surgical approaches among other variables. These have been calculated in theoretical mathematical models alone.

We evaluated all our patients using the HHS. The HHS is an easy clinician-based tool to assess the pain, deformity, function and activity levels of a patient after THA. It has a high validity and reliability [2]. The hip score is graded as poor (<70), fair (70-79), good (80-89), excellent (90-100). The scoring system requires no special training and can be completed quickly using minimal equipment. Almost all of our patients had an excellent functional outcome. None had a poor outcome. Intra-operatively, the acetabular component was placed using a pure manual free-hand technique. The cups were aimed to be placed at an angle within the suggested range of cup version. 90% of the cups were in the acceptable ranges of version.

Our study was limited by the number of cases and the duration of study. A longer and larger study could potentially reveal other complications of THA, leading to a better understanding of the effect of the acetabular cup version on the clinical and functional outcome. Using more than one scoring system may help to get a better assessment of the functional outcome.

CONCLUSION

There were 46 patients who complied with our study. Each patient underwent unilateral THA for the first time and did not have any acetabular defects. Most of our patients underwent THA for Osteoarthritis of the hip.

97.8% of our patients had an excellent functional outcome, the rest was a good outcome when graded by the HHS. About 90% of the acetabular implants were between 5-250 of anteversion. In the rest, 1 case had single episodes of dislocation which was relocated under general anaesthesia in our hospital. No further episodes of dislocation occurred. The other cases with version outside the recommended ranges did not have any episodes of dislocation but had reduced range of motion. One case in which the anteversion was reduced, had no internal rotation. However, the functional outcome of all these cases was excellent. The CT scan gives an accurate measurement of the acetabular implant position and shows a good outcome of our free hand intraoperative acetabular implant positioning. Perhaps better accuracy may be achieved using a computer navigated system.

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