

Original Research Article

THE EFFECT OF ORIENTATION OF THE ACETABULAR COMPONENT USING TRANSVERSE ACETABULAR LIGAMENT AS GUIDE ON FUNCTIONAL OUTCOMES FOLLOWING PRIMARY TOTAL HIP ARTHROPLASTY

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ABSTRACT

Background: Our aim is to investigate the acetabular component positioning using TAL & its functional outcomes in primary THA as assessed by modified Harris Hip Score (mHHS).

Materials and Methods: 30 patients were selected randomly in this prospective study after getting clearance from the research and ethical committee in a Tertiary care centre in North India. All Total Hip Arthroplasty surgeries were performed using direct lateral Hardinge's approach & used TAL was used as the guide for positioning the acetabular cup. Acetabular version and inclination were assessed using a CT scan and functional outcome was evaluated using mHHS.

Results: The mean absolute position of the acetabular cup in our study population included 15.3 ± 5.85 degrees of anteversion and 42.7 ± 5.31 degrees of inclination angle. 86.67% of patients had both acetabular version and inclination within Lewinnek's "safe zone" with only a single case of post-operative dislocation. The correlation between the cup version and mHHS was significant (p-value=0.028) whereas the correlation between acetabular inclination and mHHS was insignificant (p-value=0.29).

Conclusion: TAL is a reliable, inexpensive and patient-specific intra-operative anatomical landmark for the placement of acetabular components with efficacy comparable to that of a mechanical alignment guide (MAG).

Keywords: Acetabular cup version; Inclination angle; modified Harris Hip Score; Total Hip Arthroplasty; Transverse Acetabular Ligament.

INTRODUCTION

Orientation of the acetabular component determines the post-operative range of motion, function, survival and overall success of THA and survival.^[1-4] along with minimizing complications. Poor acetabular positioning results in short-term and long-term complications.^[5-6] subsequently, leading to increased revision rates. The risk factors for mal-orientation are minimally invasive approach, low-volume surgeons and increased BMI.^[7] This study used the TAL was used as an anatomical marker to achieve the acetabular cup orientation

intra-operatively. Viste et al. examined the possibility of using TAL as an anatomical landmark for acetabular cup orientation.^[8]

Despite multiple studies investigating complications following THA, the acetabular component orientation & its functional outcomes weren't properly investigated and reported. G. Grammatopoulos et al,^[9] studied the acetabular component orientation & its functional outcomes using Oxford Hip Score (OHS). However, in our study, the patient's functional outcome following THA has been assessed using the modified Harris Hip Score (mHHS). The secondary aim was to

evaluate the rationality of using the TAL for the acetabular cup positioning.

MATERIAL AND METHODS

Sample Size: 30 primary THA patients were enrolled in this ethical committee-approved prospective study conducted between July 2018 and June 2020 in a tertiary care centre in North India.

Participants: Patients who complied with our study without any dropouts and gave informed consent were randomly selected. Inclusion criteria were patients aged 20 years and above undergoing primary THA for various indications like OA hip, AVN of the head of the femur and non-union fracture neck of the femur. Exclusion criteria include any surgeries or trauma around the hip/acetabulum. The sample size was calculated with 99% power of the study and 1% level of significance.

Allocation & Implementation: A total of 50 patients were screened and 30 patients were selected accordingly.

Interventions: All surgeries were performed using direct lateral Hardinge's approach by the same senior hip arthroplasty surgeon. Cementless press-fit acetabular components,^[10] were implanted with polyethylene & ceramic liners and a cementless femoral stem,^[11] with a modular metallic or ceramic head was implanted. We attempted to position the acetabular component in anteversion with the inferior rim of the cup parallel to the TAL and just below,^[9]

Objectives: Post-operatively 3D-CT,^[13] of the pelvis was performed to estimate the version and inclination of the acetabular cup as CT have higher accuracy compared to other methods.^[12]

Outcomes: Anteversion of the acetabular cup on an axial CT was assessed using modified Murray's method. This data was stored in the Digital imaging and communications in Medicine (DICOM) format and used to assess the implant's version and inclination. The post-operative mHHS,^[14] scoring was evaluated in all patients & the scores were totalled to get the final mHHS.

RESULTS AND DISCUSSION

We studied acetabular component orientation using TAL & its functional outcomes in patients undergoing primary THA using the mHHS in the Indian sub-continent. Out of 30 patients, 24 males (80%) and 6 females (20%) & 15 patients (50%) were left-sided and the other 15 patients (50%) were right-sided was noted & patients who were followed up for at least 6 months. The mean age of the study population was 44.17 ± 12.67 years (mean \pm SD) with 5 patients (16.7%) aged less than 30 years, 6 patients (20%) aged 31-40 years, 7 patients (23.3%) aged 41-50 years and 12 patients (40%) aged more than 50 years.

The placement of the acetabular cup has historically been guided by the Lewinnek,^[18] "safe zone" which is inclination/anteversion of $40^\circ/15^\circ$ ($\pm 10^\circ$) respectively. Similarly, Biedermann et al,^[4] state that components with inclination/anteversion of $45^\circ/15^\circ$ had the lowest risk of dislocation.

Determining the optimal acetabular cup orientation depends on the version, inclination, depth and height,^[12] with CT as the ideal measure to ascertain the acetabular cup position. Literature analyzes the significance of acetabular cup positioning concentrating on the tribology to decide the optimum position of the cup. However, literature on functional scores as a primary outcome following THA is scarce. Hence, our study attempted to ascertain the outcome of acetabular component placement and Lewinnek's "safe zone" on the functional outcome.

Mervinosario PM et al,^[12] also used HHS for the assessment of functional outcomes post-THA. Whereas, Prateek Goyal et al,^[11] used WOMAC, HHS and SF-12 scores for the cup positioning to study the functional outcome following THA. G. Grammatopoulos et al [9] used Oxford Hip Score (OHS) to assess the functional outcome 5 years postoperatively.

The mean mHHS was found to be 84.73 ± 9.005 (mean \pm SD) post-operatively with scores ranging from 63 to 93. Out of 30 patients, 13 (43.33%) had excellent outcomes (mHHS=90-100), 11 (36.66%) had good outcome (mHHS=89-80), 2 (6.66%) had fair outcomes (mHHS=79-70) and remaining 4 patients (13.33%) had poor outcome (mHHS<69). (Table 1) (Figure 1)

The mean anteversion and inclination angle in our study was found to be 15.3 ± 5.85 and 42.7 ± 5.31 degrees (mean \pm SD) respectively while it was 21.7 ± 11.9 and 44.4 ± 6.9 degrees respectively in another study by Prateek Goyal et al,^[11] G. Grammatopoulos et al,^[9] demonstrated a mean anteversion of 9.5 and 10.7 degrees and a mean inclination angle of 45.2 and 46 degrees in males and females respectively. In another study conducted by Mervinosario PM et al,^[12] mean anteversion was found to be 15.4 degrees. The range of acetabular version and inclination in our cohort was -5 to 26 degrees and 35 to 57 degrees respectively. (Table 2) (Figure 2) (Figure 3)

A total of 28 patients (93.33%) had an inclination range within Lewinnek's safe zone post-operatively, whilst 28 patients (93.33%) were within the anteversion range. 26 patients (86.67%) had both acetabular version and inclination within Lewinnek's "safe zone". Other studies conducted by G. Grammatopoulos et al,^[9] and Prateek Goyal et al,^[11] had only 50% and 42.9% of acetabular components within Lewinnek's "safe zone" respectively. 2 patients had an inclination angle >50 degrees and one patient had an acetabular version >25 degrees (26 degrees). The acetabular cup was found to be retroverted in one case (3.33%). (Table 2)

Dislocation occurred in only one patient (3.33%) in our study population with an associated retroverted cup which was later corrected by revision THA. The patient has now recovered from nerve palsy and has a good functional outcome. Mervinrosario PM et al [12] also had a single episode of dislocation (out of 46 hips) with an anteversion of fewer than 5 degrees. Prateek Goyal et al,^[1] reported one dislocation with an anteversion angle of 0 degrees and inclination angle of 42 degrees & concluded that Lewinnek's "safe zone" has no direct effect on outcome scores. Similarly, G. Grammatopoulos et al,^[9] demonstrated a definitive dislocation risk of 1.8% for acetabular components within the "safe zone" compared to 7% for those outside it. Biedermann et al,^[15] state that minimal changes in cup positioning result in increased dislocation. Dorr et al,^[16] mention that the erroneous anteversion of the acetabular cup was a frequent cause of recurrent dislocation. Ali Khan et al,^[17] state that the acetabular component was either too anteverted (>15 degrees) or too vertical (>50 degrees) in cases of post-THA dislocations. Significant limb length discrepancy (LLD) of 3.2 cm was noted in only one case (3.33%) whereas the rest of the cases (96.67%) had LLD<1 cm. None of the patients suffered from a post-operative infection in our study (Table 2)

Therefore, it can be concluded that there is a significant cutback in the risk of dislocation with acetabular inclination/anteversion within Lewinnek's safe zone but this zone has no direct effect on patient functional outcome scores. Placing the cup in a target zone could possibly reduce this risk but will not eliminate the risk of dislocation.

In our study, the orientation of the acetabular component showed a statistically significant association between cup version and patient functional outcome score (mHHS) (p-value=0.028). Acetabular inclination angle was positively associated with mHHS, however, this correlation was not statistically significant (p-value=0.294). Nevertheless, accuracy in cup orientation remains important for tribology and hip stability. Prateek Goyal et al,^[1] also demonstrated a strong connection between cup anteversion and mHHS (p-value=0.001) but a weak connection between the inclination angle and mHHS (p-value=0.20). G. Grammatopoulos et al,^[9] demonstrated statistically significant yet, with a minimal functional improvement of achieving orientations within 45/25 degrees, with zone ranges of ± 10 or ± 15 degrees. (Table 3)

Agarwal et al,^[11] compared mechanical angle guide (MAG) and TAL usage for the placement of acetabular components and found that MAG showed significant changes in the acetabular cup version than TAL with extended surgery time, cost and complications associated with reference pin usage with MAG, which can be prevented by using TAL

as a guide. G. Grammatopoulos et al [9] state that using MAG resulted in an enhanced difference in anteversion by one-third but it was only ± 10 degrees.

Hence, it can be concluded that the Transverse acetabular ligament (TAL) can be used as a reliable, inexpensive and patient-specific intra-operative anatomical landmark for the placement of acetabular component with efficacy comparable to that of mechanical alignment guide (MAG) with no further requirement of instrumentation.

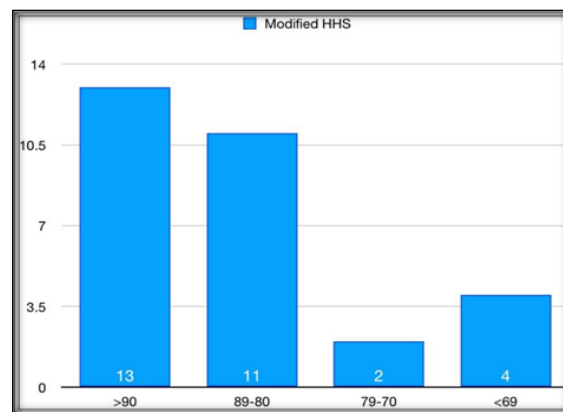


Figure 1: Post-Operative mHHS

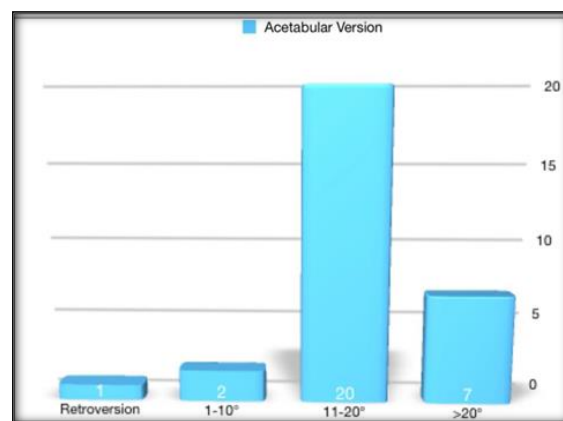


Figure 2: Acetabular Version

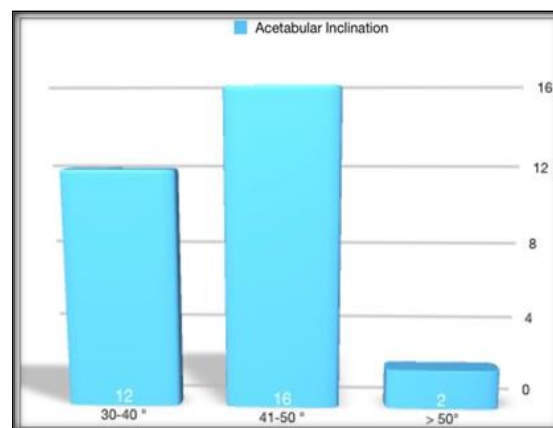


Figure 3: Acetabular Inclination

Table 1: Post-Operative mHHS

SCORE	NO. OF PATIENTS	OUTCOME	VALID PERCENTAGE
> or = 90	13	EXCELLENT	43.33
89-80	11	GOOD	36.66
79-70	2	FAIR	6.66
< or = 69	4	POOR	13.33
TOTAL	30		100

Table 2: Orientation of the Acetabular Component

Study	Anteversio n in degrees (mean±SD)	Inclinatio n angle in degrees (mean±SD)	Range of version in degrees	Range of inclinatio n angle in degrees	Componen ts with both version & inclination within Lewinnek's safe zone	No. of dislocatio ns	Risk of dislocatio n among componen ts within Lewinnek's safe zone	Risk of dislocatio n among componen ts outside Lewinnek's safe zone
Our study (using TAL as intra-operative guide)	15.3±5.85	42.7±5.31	-5 to 26 (93.33% within Lewinnek's safe zone)	35 to 57 (93.33% within Lewinnek's safe zone)	86.67%	1 (3.33%)	0%	25%
Prateek Goyal et al¹	21.7±11.9	44.4±6.9	-19.1 to 58.5	20 to 69.5	42.9%	1 (0.08%)	0%	0.14%
G. Grammatopoul os et al¹⁰ using traditional technology	10.3±7.1	45.7±7.4	-33 to 39.3	20.7 to 73.6	50%	22 (2%)	1.8%	7%
Mervinrosario PM et al¹³ (using pure manual free hand technique)	15.4	-	5 to 25 in 90% cases	-	89.13%	1 (2.17%)	0%	20%

Table 3: Correlation Between Acetabular Component Orientation & Functional Outcome

Study	Score used to assess functional outcome	P-value	
		Version * Functional outcome score	Inclination * Functional outcome score
Our study	mHHS	0.028	0.294
Prateek Goyal et al¹	WOMAC, HHS and SF-12	0.001	0.20
G. Grammatopoulos et al¹⁰	OHS	0.29	0.53
Mervinrosario PM et al¹³	HHS	Significant but p-value not calculated	Inclination angle not included in study

CONCLUSION

The prospective nature & detailed data capture were the strengths of our study. Also, we not only assessed both the dislocation rates & functional outcome with respect to the acetabular component orientation following THA.

Limitations of our study include a limited number of cases and a shorter duration of the study. The functional outcome could have been assessed better using more than one scoring system.

Conflict of Interest: The authors declare that they have no relevant financial or non-financial interests to report

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Informed Consent: Written informed consent was obtained from all patients and/or families

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