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Research Article

Functional Outcome After Total Hip Replacement Using Ceramic-on-Ceramic among Young Adult Patients

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Abstract

Background: Total hip arthroplasty (THA) by using ceramic-on-ceramic (CoC) implants has emerged as a promising solution to mitigate wear debris-related complications, such as osteolysis, specifically in younger patients. This study aims to investigate the functional outcomes after total hip replacement by CoC in patients less than 30 years old, conducted within the hospitals of Khartoum, Sudan.

Methods: A descriptive, cross-sectional, hospital-based study was carried out across the major healthcare institutions in Khartoum state from October 2021 to April 2022. A cohort of 32 patients, all aged 30 or below, who underwent total hip replacement were included. Thorough data analysis was conducted using advanced statistical techniques.

Results: The average age of included patients was 25.69 ± 2.7 years, among them, males had a slight predominance (56.3%) with a male-to-female ratio of 1.3:1. Most patients had a secondary school level of education (37.5%), while workers constituted the largest group (34.4%). The included patients were followed-up for more than six months. The mean visual analog scale (VAS) score was 7.91 ± 0.893. Additionally, the mean modified Harris hip score was 83.03 ± 4.9 (range: 72–91), highlighting the enhanced hip function achieved through the procedure. The majority of patients (65.6%) reported good functional outcomes, followed by 28.1% who attained fair outcomes and 25.8% who reported excellent outcomes.

Conclusion: The study demonstrates that CoC THA yields optimal functional outcomes among patients aged 30 years and below. The procedure exhibits remarkable potential to improve hip function and alleviate pain in this specific patient population. These findings highlight the efficacy and viability of CoC implants in younger patients, contributing to the advancement of hip arthroplasty techniques.

Keywords: ceramic-on-ceramic, functional outcome, Khartoum, Sudan, total hip replacement, young adult patients

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1. Introduction

Total hip arthroplasty (THA) as a surgical technique is commonly used to manage pain and improve functionality in patients with total hip osteoarthritis (OA) [1]. While THA leads to reduced pain, improved function, and higher quality of life, with variation from one patient to another [2], several studies have investigated the functional outcomes following the THA, justifying the need for a systematic review [3].

THA is known as a successful and cost-effective orthopedic surgery [4, 5]. It provides consistent results in patients with deteriorating degenerative hip OA by relieving pain, improving function, and enhancing the quality of life. The prevalence of hip OA is high, making it the most common underlying diagnosis leading to THA among patients with hip osteonecrosis, congenital anomalies of hip, and inflammatory disorders [6].

The success of THA depends on the interplay of osseous and soft tissue structures within the hip joint, including the proximal femur, acetabulum, labrum, and joint capsule [7, 8]. THA's goal is to substitute the deteriorated areas of the hip joint, as the number of hip prostheses implanted each year is increasing, driven by factors such as increased life expectancy and enhanced accessibility of prostheses [9].

Short- and medium-term studies have demonstrated notable enhancements in the overall well-being and functional capabilities of individuals who underwent THA [10]. The procedure is particularly beneficial for patients suffering from OA or inflammatory arthritis of the hip. The success rates are high, with most patients experiencing functional hip replacement even after 10 or 20 years [11–13].

Revision surgeries for THA are most performed due to aseptic loosening, with higher rates observed in younger patients [14, 15]. Wearing remains a challenge despite advancements in implant materials, with ceramic-on-ceramic (CoC) bearings recommended for young, active patients due to their low wear rate [16–21]. CoC bearings enable the utilization of larger femoral heads while preserving the dimensions of the acetabular component, leading to exceptional clinical results [22–28].

Implant failure in THA can be affected by patient-related factors (such as age, gender, and arthritis etiology), implant factors (like cemented vs non-cemented implants), and surgeon factors [29–33]. The success of THA is influenced by both the surgical approach and the expertise of the surgeon involved [34, 35].

Studies evaluating THA outcomes in young patients have shown promising results, indicating significant functional improvement and comparable revision rates to the general THA population [36–38]. Contemporary ceramic bearings have demonstrated good survival rates and clinical outcomes in young patients [36].

The THA is a well-known technique of alleviating pain and improving functionality in patients with hip OA. Its utilization has demonstrated a high success rate and consistent outcomes. However, factors such as patient characteristics including their age, implant choice, and surgical expertise should be carefully considered to achieve optimal outcomes. Thus, the current study aimed to assess the functional outcome following CoC total hip replacement in patients aged 30 years and below in Khartoum, Sudan.

2. Material and Methods

2.1. Study design

A descriptive cross-sectional, hospital-based study was conducted to investigate the functional outcomes following CoC of THR among patients aged 30 years and less. The study was carried out in major healthcare institutions across Khartoum state from October 2021 to April 2022.

2.2. Study participants

The study was conducted on 32 patients who underwent total hip replacement and were 30 years old or younger. The participants were selected from hospitals in Khartoum, Sudan. Inclusion criteria consisted of being diagnosed with end-stage hip joint disease and undergoing CoC total hip replacement. Patients with prior hip surgeries, congenital hip abnormalities, or systemic conditions that could impact hip function were excluded from the study.

2.3. Surgical procedure

All surgical procedures were performed by researchers who are experienced orthopedic surgeons specializing in hip arthroplasty. The CoC implants used in the procedures were cement less (BIOLOX® Forte; CeramTec AG, Plochingen, Germany).

2.4. Data collection

Data were collected using validated questionnaire, which includes demographic information such as age, gender, educational level, occupation, and clinical data related to the surgical procedure and its outcomes. Preoperative data, including diagnosis, affected hip joint, and pre-operative functional status, were obtained from medical records. Postoperative follow-up visits were done at regular intervals, and included patients were assessed for pain by visual analog scale (VAS) and functional outcome was assessed by the modified Harris hip score.

2.5. Data analysis

Data were analyzed using the statistical package SPSS version 24. Descriptive and inferential statistics were conducted. The analysis included mean and standard deviation (SD) for continuous variables, and frequencies with percentages for categorical variables. The association was assessed by a Chi-square test with a confidence level of 95%.

3. Results

A total of 32 patients who underwent CoC total hip replacement were included in this study, with a mean patients age of 25.69 ± 2.7years (range, 20–30 years). The majority of patients (21, 65.6%) were in the age group 25–30 years. Males showed slight predominance (18, 56.3%), with a male-to-female ratio of 1.3:1. Regarding educational level, 12 (37.5%) were secondary school educated, followed by 10 (31.3%) who had a university degree, and 6 (16.1%) who had only attended primary school.

All patients (100%) were free from chronic illness and none reported having a long-term medication history. All of them had a follow up duration of >6 months. Left side was the most affected site in 17 (53.1%) of them, and right side in 15 (46. 9%). The mean VAS score of the patients was

7.91 ± 0.893. (range, 6–9). The mean modified Harris hip score was 83.03 ± 4.9 (range, 72–91). The majority of patients (65.6%) reported good functional outcomes, followed by 28.1% who attained fair outcomes, while 25.8% reported excellent outcomes (Table 2).

All patients (100%) had a follow-up duration of >6 months. The mean patients' VAS score was 7.91 ± 0.893. (range, 6–9). Although, functional outcome has insignificant association with age group, gender, educational level, occupation, and affected site, most patients had good function, followed by fair and excellent (65.6%, 28.1%, 6.3% respectively). The mean modified Harris hip score was 83.03 ± 4.9 (range, 72–91).

Table 3 shows the overall function outcome of patients who underwent CoC total hip replacement in Khartoum State Hospitals from October 2021 to April 2022. Among the 32 patients in the study, 65.6% achieved a "Good" function outcome, making it the most common result. A total of 28.1% of patients had a "Fair" function outcome, and only a small proportion of 6.3% achieved an "Excellent" function outcome. Fortunately, none of the patients recorded a "Poor" outcome, indicating a successful procedure with favorable functional outcomes.

Table 4 examines the relationship between age groups and function outcomes following CoC total hip replacement. The data shows that age does not appear to be significantly associated with the function outcome (*P*-value = 0.554). Table 5 examines the impact of gender on function outcomes following CoC total hip replacement. The results reflect that gender does not have a significant association with the functional outcomes (*P*-value = 0.757). Table 6 explores the relationship between education levels and function outcomes following CoC total hip replacement. The results show an insignificant association between education level and functional outcome (*P*-value = 0.129).

Table 7 investigates the association between occupation and function outcomes following CoC total hip replacement. The findings suggest that the occupation is not significantly associated with functional outcomes (*P*-value = 0.137). Table 8 analyzes the relationship between the affected hip site and function outcomes following CoC total hip replacement. The results suggest that the affected site (right or left hip) is not significantly associated with functional outcomes (*P*-value = 0.629).

4. Discussion

The success of THR has led to its expanded use in younger and more physically active individuals. However, the younger population's higher activity levels and demands often result in higher revision rates compared to older patients, with aseptic loosening and wear-induced osteolysis being the main causes of failure. While limited studies have examined the long-term outcomes of CoC implants in younger patients, the outcomes of CoC bearings in patients over 40 years old have been extensively studied, demonstrating positive results. Additionally, previous research has shown satisfactory patient experiences with CoC THR.

There is limited research on the functional outcomes of THA, particularly in CoC THA. Hannouche *et al.* reported an increase in the mean Merle d'Aubigne-Postel score from 10.1 ± 4.0 to 17.6 ± 1.1 among patients younger than 20 years [39]. Many patients were able to resume their occupational and sports activities, and the mean HOOS score was 79.3 ± 13.8. Wang *et al.* observed a significant improvement in function, as measured by the HHS and UCLA scores, with

Table 1: Follow-up duration of patients who underwent ceramic-on-ceramic total hip replacement (30 years old and below) in Khartoum state hospitals.

Follow-up duration (months)	Frequency	Percentage (%)
<3	0	0.0
3–6	0	0.0
>6	32	100.0
Total	32	100.0

Table 2: Visual analogue scale among patients who underwent ceramic-on-ceramic total hip replacement (30 years old and below) in Khartoum state hospitals.

Visual analogue scale	Mean ±SD	Range
	7.91 ± 0.893	6–9
VAS	**Frequency**	**Percentage (%)**
6	1	3.1
7	11	34.4
8	10	31.3
9	10	31.3
Total	32	100.0

Table 3: Overall function outcome of patients who underwent ceramic-on-ceramic total hip replacement (30 years old and below) in Khartoum state hospitals.

Overall MHHS	Frequency	Percentage
Fair	9	28.1
Good	21	65.6
Excellent	2	6.3
Poor	0	0.0
Total	32	100.0

Table 4: Age group and function outcome cross tabulation.

Age group (yrs)		Function outcome			Total
		Fair	Good	Excellent	
<25	Count	3	8	0	11
	%	33.3%	38.1%	0.0%	34.4%
>25	Count	6	13	2	21
	%	66.7%	61.9%	100.0%	65.6%
Total	Count	9	21	2	32
	%	100.0%	100.0%	100.0%	100.0%

P-value = 0.554.

mean preoperative HHS of 46.3 ± 12.0 points and a final follow-up score of 92.5 ± 5.6 points [41]. Chana *et al.* reported an increase in function using the modified University of California, Los Angeles activity level score from a mean of 6.4 preoperatively to 9.0 at the 10-year postoperative period [41]. Walker *et al.* found a weighted mean difference of 42.17 points in the Harris Hip Score after THA among patients with a mean age of 22.7 years [38]. Yoo *et al.* reported a mean MHHS of

Table 5: Gender and function outcome cross tabulation.

Gender		Function outcome			Total
		Fair	Good	Excellent	
Male	Count	6	11	1	18
	%	66.7%	52.4%	50.0%	56.3%
Female	Count	3	10	1	14
	%	33.3%	47.6%	50.0%	43.8%
Total	Count	9	21	2	32
	%	100.0%	100.0%	100.0%	100.0%

P-value = 0.757.

Table 6: Education level and function outcome cross tabulation.

Education		Function outcome			Total
		Fair	Good	Excellent	
Illiterate	Count	0	4	0	4
	%	0.0%	19.0%	0.0%	12.5%
Primary school	Count	4	2	0	6
	%	44.4%	9.5%	0.0%	18.8%
Secondary school	Count	2	8	2	12
	%	22.2%	38.1%	100.0%	37.5%
University	Count	3	7	0	10
	%	33.3%	33.3%	0.0%	31.3%
Total	Count	9	21	2	32
	%	100.0%	100.0%	100.0%	100.0%

P-value = 0.129.

Table 7: Occupation and function outcome cross tabulation.

Occupation		Function outcome			Total
		Fair	Good	Excellent	
Worker	Count	4	7	0	11
	%	44.4%	33.3%	0.0%	34.4%
Employee	Count	1	2	0	3
	%	11.1%	9.5%	0.0%	9.4%
Without job	Count	2	2	2	6
	%	22.2%	9.5%	100.0%	18.8%
Housewife	Count	0	5	0	5
	%	0.0%	23.8%	0.0%	15.6%
Student	Count	2	5	0	7
	%	22.2%	23.8%	0.0%	21.9%
Total	Count	9	21	2	32
	%	100.0%	100.0%	100.0%	100.0%

P-value = 0.137.

97.0 ± 3.2 points among patients with a mean age of 41 years, with minimal complications [42]. These

Table 8: Affected site and function outcome cross tabulation.

Affected site		Function outcome			Total
		Fair	Good	Excellent	
Right	Count	3	11	1	15
	%	33.3%	52.4%	50.0%	46.9%
Left	Count	6	10	1	17
	%	66.7%	47.6%	50.0%	53.1%
Total	Count	9	21	2	32
	%	100.0%	100.0%	100.0%	100.0%

P-value = 0.629.

findings suggest that THA by CoC is associated with good to excellent functional outcomes. CoC bearings have a longer lifespan and lower risk of wear-induced osteolysis compared to ultra-high molecular weight polyethylene (UHMWPE).

Studies that were conducted among younger patients have linked UHMWPE debris to long-term osteolysis and loosening. Although highly cross-linked polyethylene (HCLPE) acetabular implants show better wear rates, long-term clinical findings are still lacking. In summary, CoC bearings in primary THA have demonstrated positive clinical and radiological outcomes, with undetectable wear rates and excellent function, particularly in younger patients, both in the short- and long-term studies [38, 40, 43]. This indicates the applicability and feasibility of using the technique in developing countries where the infrastructure and facilities are limited.

5. Limitations

The limitations of this study include that it was conducted among selected young people which limits the generalizability of the findings. Another limitation was it was conducted on small sample size in one city of the country. Furthermore, the limitation related to the measurements assessed only the functional outcomes while other parameters were not considered in the study.

6. Conclusion

It can be concluded that the mean patient's VAS score was acceptable. Although, functional outcome had insignificant association with age group, gender, educational level, occupation, and affected site, the majority of the patients had good function, followed by fair and excellent and the mean modified Harris hip score.

Declarations

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Ethical Considerations

Ethical approval for this study was obtained from the Ethical Committee of the International University of Africa in Sudan, under the reference number IUA/FM/04/04/20-14 on 2020, April 4.

Competing Interests

The authors declare no competing interests to be addressed.

Availability of Data and Material

The data for this study is available upon request. Interested individuals can contact the corresponding author to obtain access to the data.

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