

EFFECT OF PRE-OPERATIVE SERUM VITAMIN-D LEVELS ON POST-OPERATIVE OUTCOME IN TOTAL KNEE ARTHROPLASTY

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ABSTRACT

Objective: To determine the effect of pre-operative serum vitamin-D levels on the post-operative outcome in patients undergoing total knee arthroplasty.

Methodology: This prospective cohort study was conducted at the Department of Orthopaedics, Benazir Bhutto Hospital, Rawalpindi, Pakistan from 11th May 2017 to 10th May 2018. A total of 110 patients undergoing primary unilateral total knee arthroplasty (TKA) were enrolled in the study. Patients were placed into two groups. Group A included patients who had deficient vitamin-D₃ levels (<30 ng/ml) while group B had patients with sufficient levels of vitamin-D₃ (≥30 ng/ml). Functional evaluation was done pre-operatively and at 03 months post-operatively using American knee society score (KSS), Alternate step test (AST) and Six-meter walk test (SWT). Mean functional scores were compared using student's t-test in SPSS version 23.

Results: There were 48 (43.64%) male and 62 (56.36%) female patients. Mean age of patients in group A was 60.87 ±5.10 years while in group B it was 60.09 ±4.78 years. Group A patients had mean vitamin-D levels of 13.56 ±6.12 ng/ml and those in group B had 41.49 ±9.95 ng/ml. At 3 months post-op, functional KSS showed a significant difference between the two groups (65.98 ±5.10 in group A and 74.87 ±5.02 in group B, p <0.01). The performance tests showed significant difference between the 02 groups (16.46 ±2.78 vs. 15.12 ±3.37, p =0.02 for AST) while (8.48 ±2.06 vs. 7.49 ±1.88, p =0.01, for SWT), respectively.

Conclusion: Pre-operative vitamin-D levels significantly affect the post-operative functional outcome in TKA.

Key Words: Total knee arthroplasty, Vitamin-D, Performance tests

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INTRODUCTION

Vitamin-D and its role in orthopaedic pathologies has long been theorized. There is growing evidence that optimum levels of vitamin-D are crucial for musculoskeletal health¹. Screening for vitamin-D deficiency is not a routine practice in orthopaedic medicine despite almost 1 billion estimated cases worldwide^{2,3}. Vitamin-D deficiency leads to arthritic changes and gait disturbances in the elderly causing repeated falls^{4,5}. Many studies also link the deficiency to diabetes and cardiovascular disease^{6,7}. Serum vitamin-D levels are influenced by dietary intake, sunlight exposure and demographic and metabolic status of the patients⁸. Older people are more deficient in vitamin-D as the changes in their skin reduce the capacity of its production and also their nutritional status is different from that of younger people⁹. International Osteoporosis Foundation as well as Osteoporosis Canada have considered 30 ng/ml as the minimal normal level considering the relationship between the level

of vitamin-D, response of parathyroid hormone and the reabsorption of calcium^{10,11}. Many studies carried out showed a positive correlation between vitamin-D status and the joint movement^{4,5,12}.

Total knee replacement (TKR) is the treatment of choice for patients with advanced osteoarthritis of knee. TKR not only relieves pain but also improves the functional outcome of the patient. TKR being a major procedure is associated with insult to the muscle and bone. Limiting muscle injury results in early post-operative functional outcome after total knee arthroplasty (TKA)¹³. As a key regulator of calcium and phosphate, low levels of vitamin-D pose a potential risk for fractures, joint weakness and muscle aches³. There is no standardized criterion to establish and document its deficiency. Recent studies suggest that insufficiency starts at level <40 ng/ml, whereas the clinical signs and symptoms arise with serum vitamin-D levels of <25 ng/ml^{14,15}. Many methods are employed to correct the deficiency including simple

home remedies such as sunlight exposure, food fortification and medically by a supplementation regimen¹⁶.

The objective of this study was to quantify and assess the effect of hypovitaminosis D on the post-operative functional outcome following TKA since there is no existing study done in our local population highlighting the role of serum vitamin-D levels. The study investigated whether or not there is a significant link between deficient vitamin-D levels and poor functional outcome after TKA. Once the link has been established, pre-operative screening for vitamin-D deficiency will be validated for all at-risk patients and the deficiency would be corrected before the patient undergoes surgery, increasing overall success rate of TKA.

METHODOLOGY

This prospective cohort study was conducted at the Department of Orthopaedics, Benazir Bhutto Hospital, Rawalpindi over a period of 01 year i.e. from 11th May 2017 to 10th May 2018. Patients aged 20 years and above, belonging to either gender undergoing primary, unilateral total knee arthroplasty (TKA) for advanced osteoarthritis knee were included in the study. Patients with stroke or neuromuscular disorder; those undergoing revision TKR; those with metabolic bone disorders like hypo- or hyperparathyroidism, chronic kidney disease; spinal disorder which will affect the rehabilitation; those with history of taking calcium, vitamin-D or bisphosphonate 06 months prior to surgery; psychiatric illnesses; advanced osteoarthritis of hip/ankle; post-operative complications like infection, pulmonary thromboembolism, etc were excluded from the study. The pre-operative serum vitamin-D₃ levels were measured three days prior to surgery and the patients were divided into two groups; A and B. Patients having levels <30 ng/ml were labelled as vitamin-D deficient and placed in group A whereas those with levels ≥30 ng/ml were labelled as having sufficient vitamin-D and placed in group B¹⁷. Vitamin-D₃ levels were measured using Chemiluminescent Microparticle Immunoassay (CMIA) on an ARCHITECT–state of the art machine.

Sample size of the study calculated using open source calculator, Open Epi version 3.04, keeping confidence interval 95%, power of study 80% and effect size (mean difference = 7.7-8.8) as 1.1. Out of the 114 patients, based on vitamin-D levels 57 were placed in each group; A and B. As 02 patients developed complications, i.e. 01 patient in group A had post-operative surgical site infection and 01 in group B developed pulmonary thromboembolism, so they were excluded from the study. One patient from each group lost to follow-up and were excluded. So, 110 patients who met the inclusion criteria were included using non-probability consecutive sampling technique.

After approval from the ethical review committee of the hospital, a written informed consent was obtained from all patients involved in the study and data were documented on a pre-formed questionnaire detailing age, gender, body mass index (BMI), American society of anaesthesiologist score (ASA) and any history of vitamin-D supplementation. The American knee society score (KSS), Alternate step test (AST) and Six-meter walk test (SWT) were applied on all patients to evaluate mobility. All arthroplasties were performed by the same consultant orthopaedic surgeon using the mid-vastus approach and Zimmer posterior cruciate substituting cemented implants were used. A pre-set rehabilitation protocol was followed by all the patients undergoing TKA. This protocol comprised of 3 phases, i.e. phase-I (early-function phase) from 1st post-operative day to 2nd week, phase-II (progressive-function phase) from 3rd post-operative week to 6th week and phase-III (advanced-function phase) from 7th post-operative week till 12th week. Phase-I included general mobility, stretching exercises and functional training. This was done as in-patients. Phases II and III comprised of strengthening exercises, closed-chain activity, balance training and aerobic conditioning in addition to those mentioned in phase-I¹⁸. The knee society score (KSS) consisted of functional and clinical parameters¹⁹.

Alternate step test (AST) was done by asking the patient to place his/her right and left foot on a step that had a height of 18cm and a depth of 40cm as possibly fast as he/she was able to do. Time taken in completing 08 steps was noted²⁰. In SWT, the patients were made to walk in the corridor with their normal speed for 06 metres²¹. The findings of these tests were noted by the same observer. The tests were performed one day prior to surgery and were repeated 3 months after TKA when patients were re-assessed during follow-up. The data was entered into SPSS version 23. The mean scores and mean time for performance of tests were compared using student's t-test. Categorical variables were presented as frequency and percentage and compared by chi-square test. P-value was considered significant if ≤0.05.

RESULTS

Out of 110 patients included in the study, 48 (43.64%) were male and 62 (56.36%) females. Mean age was 60.48 ±4.94 years. Average BMI of patients was 25.28 ±2.59 Kg/m². Most of the patients belonged to ASA 1-2 (n=68, 61.82%). Other demographic details are shown in Table 1.

Pre-operative functional and clinical KSS had no significant difference between the two groups (p >0.05). Performance tests, i.e. AST and SWT also showed no significant pre-operative difference between groups A and B (Table 2).

Table 1: Demographic and clinical details

Variables		Group A (n=55)	Group B (n=55)	P Value
Gender	Male (n=48)	25	23	0.70
	Female (n=52)	30	32	
American Society of Anaesthesiologist Score	1-2 (n=68)	32	36	0.43
	3-5 (n=42)	23	19	
Side (TKA)	Right (n=53)	25	28	0.57
	Left (n=57)	30	27	
Mean Age (Years)		60.87 ± 5.10	60.09 ± 4.78	0.41
BMI (kg/m ²)		25.44 ± 2.52	25.12 ± 2.69	0.52
Vitamin-D Levels (ng/ml)		13.56 ± 6.12	41.49 ± 9.95	<0.01

Table 2: Pre-operative scores

Variables	Group A (n=55)	Group B (n=55)	P Value
Knee Society Score (Functional)	53.27 ± 4.71	54.02 ± 5.11	0.43
Knee Society Score (Clinical)	55.22 ± 4.54	56.25 ± 5.97	0.31
Alternate Step Test (AST)	22.28 ± 2.78	23.12 ± 3.36	0.16
Six-meter Walk Test (SWT)	11.87 ± 2.08	11.54 ± 2.07	0.39

Table 3: Post-operative scores

Variables	Group A (n=55)	Group B (n=55)	P Value
Knee Society Score (Functional)	65.98 ± 5.10	74.87 ± 5.02	<0.01
Knee Society Score (Clinical)	84.02 ± 4.77	85.07 ± 4.87	0.25
Alternate Step Test (AST)	16.46 ± 2.78	15.12 ± 3.37	0.02
Six-meter Walk Test (SWT)	8.48 ± 2.06	7.49 ± 1.88	0.01

At 03 months post-operatively, the functional KSS improved from 53.27 ± 4.71 to 65.98 ± 5.10 in group A while from 54.02 ± 5.11 to 74.87 ± 5.02 in group B; which was statistically significant ($p < 0.01$). Among the performance tests, AST and SWT showed significant differences between groups A and B with p values 0.02 and 0.01 respectively (Table 3).

DISCUSSION

Deficiency of Vitamin-D is not only a common medical condition but has also not been thoroughly investigated despite the fact that a majority of population of many countries world over have significantly low levels of vitamin-D. Sufficient vitamin-D levels are required to maintain an optimal level of well being²². This study was done based on the observation that the elderly population with osteoarthritis of the knee are highly deficient in Vitamin-D²³. In our study, subjects with deficient vitamin-D levels (group A) and sufficient vitamin-D levels (group B) who underwent TKA showed no significant difference when age of patients was compared. Mean age of patients included in our study was 60.48 ± 4.94

years which was comparable to a study by Raynauld et al²⁴ in which mean age of the patients undergoing TKA was 65.8 ± 7.5. This was also comparable to a study by Memon et al²⁵ in which mean age of the patients undergoing TKA was 55.58 ± 8.35 years. The results indicated that osteoarthritis and consequently TKA is more common in elderly patients. As discussed before, elderly patients have greater Vitamin-D deficiency due to poor nutritional status and limited sunlight exposure. Wei et al²⁶ in his recently published study showed that reduced vitamin-D levels resulted in a poor physical function in elderly.

KSS scoring was used to assess the pre- and post-operative functional status as in a study published by Razak et al²⁷ in 2016 in which he mentioned that KSS is a significant predictor of functional outcome after TKA. Similar reliability of KSS in patients undergoing TKA was also mentioned in another study published in 2012²⁸. In our study, KSS scoring did not show any significant difference pre-operatively between the two groups ($p > 0.05$) regardless of a difference between the vitamin-D status of both groups ($p < 0.01$). Shin et al¹ showed similar

results in his study. This could be because of excessive pain that occurs in osteoarthritis knee. Pain compromises the function as it is so severe that daily life of the patient is affected²⁹. These results were in contrast to a study by Jansen et al³⁰ in which he showed a significant difference in pre-operative KSS between vitamin-D deficient and sufficient groups ($p = 0.047$). Post operatively, KSS scores improved for all the patients undergoing TKA and the functional component of group B patients was significantly improved as compared to the pre-operative value and the post-op group A subjects ($p < 0.01$). These results were in accordance with the study done by Shin et al¹ where the post-operative functional KSS had a significant difference between the two groups ($p = 0.045$).

Patients with vitamin-D deficiency (group A) had poor results of AST and SWT when compared with the patients with sufficient vitamin-D levels (group B) post-operatively. At 03 months post-TKA, group A patients had an AST score of 16.46 ± 2.78 whereas group B patients had 15.12 ± 3.37 with p value 0.02. Similarly, SWT was 8.48 ± 2.06 in vitamin-D deficient group and was calculated to be 7.49 ± 1.88 with $p = 0.01$. These results were in accordance with another study by Manoy et al³¹ who reported that when vitamin-D levels improved from deficient to sufficient levels with supplementation, the performance tests showed a significant difference between the two groups ($p < 0.001$).

LIMITATIONS

Our study was limited due to the fact that even though patients who were taking vitamin-D supplements were excluded from the study but sunlight exposure and nutritional status of the patients were not taken into account. Another limitation of this study was short post-operative follow-up of three months only. But one of the strengths of our study was that it was the first study conducted on Asian population undergoing TKA which correlates vitamin-D levels and post-operative functional outcome.

CONCLUSION

Pre-operative vitamin-D levels significantly affect the post-operative functional outcome in TKA. Therefore, it is of importance that vitamin-D status of the patient is confirmed before surgery so that their levels can be optimized pre-operatively to obtain a better surgical outcome.

RECOMMENDATIONS

Vitamin-D deficiency can be corrected by supplementation; therefore we can consider it as a pre-requisite for all patients with vitamin-D deficiency who are planning to undergo TKA so that post-operatively their functional outcome is improved.

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CONTRIBUTORS

JK was involved in conceptualization of study design, data collection, data analysis and interpretation, drafting and critical revision of the article. RA contributed in literature search and final approval of the version to be published. RAA did data collection and did statistical analysis. All authors contributed significantly to the submitted manuscript.