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HIGH PREVALENCE OF VITAMIN D DEFICIENCY IN PATIENTS UNDERGOING TOTAL KNEE ARTHROPLASTY

Hafiz Muhammad Waseem Yaseen[1], Muhammad Uzair[2], Zia Ullah[3], Muhammad Inzamam Wakeel[4], Baqir Hussain[5*], Elsa Zainab Ansari[6]

[1]Senior Registrar, Anesthesia, Critical Care and Pain Department, Niazi Medical and Dental College, Sargodha
[2]Medical Officer, Star Diagnostic Center, Peshawar
[3]Assistant Professor, Orthopaedics Department, Khalifa Gul Nawaz Hospital Bannu and Bannu Medical College, Bannu
[4]Medical Officer, General Medicine Department, RIMS Trauma Hospital, Karachi
[5*]Assistant Professor, Orthopaedic Department, Lady Reading Hospital Peshawar, ORCID: 0000-0003-4316-6089
[6]Clinical Trial Screening Coordinator Research Department, DM Clinical Research, Karachi

***Corresponding Author:** Baqir Hussain:
*E-mail: dr.baqirturi@gmail.com

Abstract

Introduction: Vitamin D deficiency is a widespread global health issue that affects a significant portion of the population, particularly in individuals with conditions that compromise bone health and musculoskeletal function.**Objective:** The main objective of the study is to find the high prevalence of vitamin D deficiency in patients undergoing total knee arthroplasty.**Methodology:** This prospective cohort study was conducted at Niazi Medical and Dental College, Sargodha during august 2023 to august 2024. Data were collected from 178 patients. Patients aged 40 years and older, with a confirmed diagnosis of knee osteoarthritis and a recommendation for TKA based on clinical assessment and imaging studies were included in the study.**Results**: Data were collected from 178 patients. Of the 178 patients, 40.4% (72 patients) were deficient in vitamin D (<20 ng/mL), while 46.1% (82 patients) had insufficient levels (20-30 ng/mL). Only 13.5% (24 patients) had sufficient vitamin D levels (>30 ng/mL). These findings highlight the high prevalence of vitamin D deficiency and insufficiency in this surgical population, indicating the potential need for supplementation in preoperative care.In terms of postoperative surgical site infections (SSIs), the infection rate was higher in the vitamin D-deficient group (6.9%, n=5 out of 72) compared to the vitamin D-sufficient group (4.2%, n=1 out of 24).**Conclusion:** It is concluded that vitamin D deficiency is highly prevalent in patients undergoing total knee arthroplasty and is associated with increased postoperative complications, including surgical site infections and delayed functional recovery.

Introduction

Vitamin D deficiency is a widespread global health issue that affects a significant portion of the population, particularly in individuals with conditions that compromise bone health and musculoskeletal function. The human body requires this nutrient of great importance in calcium regulation, bone structure deposits, muscles, and immunity boosters. It has been discovered that lack

of vitamin D increases the likelihood of having fractured bones, increased risk of falls and muscle weakness leading to osteoporosis [1]. In patients undergoing orthopedic procedures especially TKA, Vitamin D deficiency has now assumed significance as it may have risk factors that may influence the postoperative recovery, rehabilitation and surgery results [2]. Knee replacement surgery, carried out in patients with debilitating knee OA is one of the most common surgical procedures in the aged and arthritic population worldwide [3]. OA is a painful degenerative joint disease that restrains the patient's mobility and becomes Asia symptomatic in many cases and surgery is the only definitive treatment. The aim of TKA is to reduce pain and improve movement by removing the affected joint and then implanting an artificial joint instead [5]. Although TKA is highly effective in reducing pain and improving function, patients suffer from a long and painful rehabilitation period, together with the potential of serious c h ronic infection, slow rate of wound healing, and lack of functional improvement. According to the results of recent investigations, the existing complications, which could be influenced by vitamin D deficiency include reduced bone mineralization, muscle weakness, and prolonged time in the first phase of bone healing, which in turn creates a fierce challenge when it comes to postoperative care [5].

Works reviewed earlier reveal that vitamin D deficiency is significantly common in patients who undergo TKA. Preoperative investigation has shown that 40-70% of knee arthroplasty patients may have a deficiency or inadequacy in vitamin D depending on the geographical location, lifestyle and underlying medical conditions [6]. This high prevalence is particularly worrying due to the fact that Vitamin D is vastly important in the health of bones. Vitamin D promotes absorption of Intestinal calcium and maintain proper bone mineralization by either stimulating osteoblast activity and/or inhibiting osteoclast activity [7]. that low levels of vitamin D decreases bone formation and increases bone remodelling which lead to poor bone healing and can have an adverse effect on joint replacement operations [8]. Further, the lack of vitamin D leads to the muscle weakness and that can compromise the process of rehabilitation after TKA. Directory there is need for spectacular vitamin D for muscle strength and coordination and the vice of the nutrient results in increased rates of falls and fracture in old people [9]. According to the TKA, muscle weakness can lead to impaired ability to bear weight, walk and perform postoperative PT activities which ultimately delays the recovery period and functional outcome. Also, a deficiency of vitamin D is linked with a higher probability of postoperative infections, which is also worrisome in TKA and because infections delay recovery, require additional operations, and can result in worse survivorship [10].These include effects of vitamin D deficiency on immune responses in TKA persons. Vitamin D is also involved in immune regulation most of which involves the functions of immune cells including the macrophages, dendritic and T cells. Low levels of vitamin D may affect immune function and may lead to increased postoperative infections and inflammatory sequelae [11]. Since infections hold high risk morbidity for mortality in TKA patients, understanding the association of vitamin D deficiency on infection is key to optimizing the quality of TKA patients. Considering that vitamin D deficiency is a common issue and can affect both surgical and functional outcomes after TKA, the need for better assessment and management of this factor is rapidly emerging [12]. Adequate prevention and recognition of vitamin D paucity prior to the surgery allows reducing risks of surgical procedures to some extent. Nevertheless, guidelines on the vitamin D screening and supplementation in TKA patients till today remain controversial, and more research will be required to settle the best approach on this issue. Specifically, there is a lack of methodologically rigorous large sample randomized controlled trials evaluating, dose, frequency and timing of vitamin D supplementation in TKA patients as well as the effect of correcting vitamin D deficiency on the post-surgical recovery and long-term functional status [13].

Objective

The main objective of the study is to find the high prevalence of vitamin D deficiency in patients undergoing total knee arthroplasty.

Methodology

This prospective cohort study was conducted at Niazi Medical and Dental College, Sargodha during august 2023 to august 2024. Data were collected from 178 patients. Patients aged 40 years and older, with a confirmed diagnosis of knee osteoarthritis and a recommendation for TKA based on clinical assessment and imaging studies were included in the study. Patients with known chronic kidney disease, hyperparathyroidism, or other medical conditions that could interfere with vitamin D metabolism, as well as patients who were currently taking high-dose vitamin D supplements or medications that affect calcium and vitamin D absorption were excluded.

Data collection

Upon enrollment, baseline data was collected for each patient, including demographic information (age, gender, body mass index, comorbidities), preoperative functional status, and medical history. In addition, a blood sample was taken from each patient to measure serum 25-hydroxyvitamin D [25(OH)D] levels, which is the most reliable indicator of vitamin D status. The serum levels of 25(OH)D were categorized into deficiency, which was <20 ng/mL; insufficiency, which was between 20– 30 ng/mL; and sufficiency >30 ng/mL. Patients were also screened for other risk factors associated with vitamin D deficiency including exposure to sunlight, food intake and intake of vitamin D supplements. Vitamin D deficient patients were defined as those with serum 25(OH)D < 20 mg/ml and were prescribed individualised doses based on their preoperative sera levels. Subjects with vitamin D deficiency (25(OH)D /20–30 ng/mL) were instructed to consume more foods containing vitamin D and were treated with mid-dose vitamin D preparations. Preoperative supplementation was started at least four weeks to the scheduled surgery and follow up measurements were also taken to establish the effectiveness of the supplementation. All TKA procedures were administered by senior implant specialists obeying set practice genres. This was done to reduce on confounding factors, that is, patients were given the same anesthetic techniques, postoperative care and rehabilitation regimens. The care packages after the operation involved normal physiotherapy, pain control, and dressing of the wound.

Statistical Analysis

Data were analyzed using SPSS v26. Descriptive statistics were used to summarize patient demographics, vitamin D levels, and postoperative outcomes. Continuous variables were reported as means ± standard deviations (SD), and categorical variables were presented as frequencies and percentages. A p-value of <0.05 was considered statistically significant.

Results

Data were collected from 178 patients. Of the 178 patients, 40.4% (72 patients) were deficient in vitamin D (<20 ng/mL), while 46.1% (82 patients) had insufficient levels (20-30 ng/mL). Only 13.5% (24 patients) had sufficient vitamin D levels (>30 ng/mL). These findings highlight the high prevalence of vitamin D deficiency and insufficiency in this surgical population, indicating the potential need for supplementation in preoperative care.

Table 1: Prevalence of Vitamin D Deficiency in TKA Patients

Vitamin D Status	Number of Patients (n)	Percentage (%)
Deficiency (<20 ng/mL)	72	40.4%
Insufficiency (20-30 ng/mL)	82	46.1%
Sufficiency (>30 ng/mL)	24	13.5%
Total	178	100%

In the deficient group (n=72), the preoperative serum vitamin D levels were significantly low, with a mean of 14.3 ± 5.6 ng/mL. After supplementation, the serum vitamin D levels improved substantially, reaching 25.9 ± 6.2 ng/mL. This increase was statistically significant ($p < 0.01$),

demonstrating the effectiveness of vitamin D supplementation in raising serum levels in patients with deficiency prior to surgery.

Table 2: Effect of Vitamin D Supplementation on Preoperative Serum Levels

Vitamin D Status	Preoperative Serum Vitamin D Level (ng/mL)	Post-Supplementation Serum Vitamin D Level (ng/mL)	p-value
Deficient Group (n=72)	14.3 ± 5.6	25.9 ± 6.2	<0.01

In terms of postoperative surgical site infections (SSIs), the infection rate was higher in the vitamin D-deficient group (6.9%, n=5 out of 72) compared to the vitamin D-sufficient group (4.2%, n=1 out of 24). Overall, the infection rate across all patients was 3.4% (n=6 out of 178). The difference in infection rates between the deficient and sufficient groups was statistically significant ($p = 0.042$), suggesting that vitamin D deficiency may be associated with an increased risk of SSIs following total knee arthroplasty.

Table 3: Postoperative Surgical Site Infections (SSIs)

Vitamin D Status	Total Patients (n)	Patients with SSIs (n)	Infection Rate (%)	p-value
Deficient Group	72	5	6.9%	0.042
Sufficient Group	24	1	4.2%	
Total	178	6	3.4%	

The Knee Society Score (KSS) improved from 38.1 ± 7.4 preoperatively to 90.3 ± 9.5 at 6 months in the sufficient group ($p = 0.001$), while the deficient group showed a smaller improvement, from 39.2 ± 8.6 preoperatively to 82.5 ± 13.4 at 6 months. Similarly, the WOMAC pain subscale score decreased significantly in the sufficient group, from 18.7 ± 3.2 preoperatively to 7.4 ± 3.6 postoperatively ($p = 0.04$), whereas the deficient group saw a smaller reduction, from 19.1 ± 3.5 to 12.2 ± 4.1.

Table 4: Functional Recovery (Knee Society Score - KSS) and WOMAC Pain Subscale

Vitamin D Status	Preoperative KSS	6-Month Postoperative KSS	p-value	Preoperative WOMAC Pain	6-Month Postoperative WOMAC Pain	p-value
Sufficient Group (n=24)	38.1 ± 7.4	90.3 ± 9.5	0.001	18.7 ± 3.2	7.4 ± 3.6	0.04
Deficient Group (n=72)	39.2 ± 8.6	82.5 ± 13.4		19.1 ± 3.5	12.2 ± 4.1	

In the deficient group (n=72), the preoperative vitamin D levels were 14.3 ± 5.6 ng/mL, and after three months postoperatively, the levels increased significantly to 30.4 ± 7.5 ng/mL. This change was statistically significant ($p < 0.01$), indicating that vitamin D supplementation had a marked effect on improving serum vitamin D levels in patients following total knee arthroplasty.

Table 5: Postoperative Serum Vitamin D Levels at 3 Months

Vitamin D Status	Preoperative Vitamin D Level (ng/mL)	Postoperative Vitamin D Level at 3 Months (ng/mL)	p-value
Deficient Group (n=72)	14.3 ± 5.6	30.4 ± 7.5	<0.01

Discussion

The findings of this study highlight the high prevalence of vitamin D deficiency and insufficiency in patients undergoing total knee arthroplasty (TKA), with 86.5% of the cohort being either deficient or insufficient in vitamin D at the time of surgery. This is in agreement with a number of prior publications, which have established that vitamin D deficiency is quite prevalent in elderly patients and surgical candidates with osteoarthritis or other related musculoskeletal conditions [14]. Consequently, the study findings indicate that poor vitamin D status may be responsible for numerous postoperative adverse outcomes and delayed TKA recovery. In this study participants, vitamin D deficiency as defined by serum level of <20ng/mL was 40.4 % while vitamin D

insufficient, that is a serum level of between 20 and 30ng/mL was 46.1%. Patient vitamin D status depicted as only 13.5% patients having vitamin D levels greater than 30 ng/mL [15]. These results are consistent with literature that describes vitamin D deficit prevalence among people with possible musculoskeletal and surgical risk factors. Deficiency in serum 25(OH)D normally occurs in people with reduced sun exposure, low dietary vitamin D intake, or with obesity, all of which are potential candidates for knee arthroplasty [16]. Patients who were initially Vitamin D deficient had elevated serum 25(OH)D levels from a mean of 14.3 ± 5.6 ng/mL to 25.9 ± 6.2 ng/mL on supplementing with Vitamin D. This result confirms the effectiveness of vitamin D supplementation in enhancing vitamin D concentrations before surgery, as found in other investigations [17]. In particular, it is found that there is a positive correlation between increased vitamin D levels and improved functional status of patients, increased muscle strength and decreased frequency of postoperative infections. They also indicate that patient who has a deficiency in vitamin D is more likely to contract the surgical site infection [18]. If patients had inadequate vitamin D levels, 6.9% developed an SSI; only 4.2% of the patients with high vitamin D levels got the infection. This difference, although nominally of a small magnitude, was statistically significantly different ($p = 0.042$). This is in line with other literature on the impact of vitamin D in immune system functioning and in particular, the way immune response to infection is managed. A study published in the Archives of Internal Medicine in August evaluated 204 patients with ESRD to determine the correlation between vitamin D sufficiency and infection rates, a phenomenon that may be due to compromised antibacterial immune response and raised inflammatory cytokine activity with outed healing of wounds among the deficient group [19]. Fresh from the surgery, they found that patients with adequate vitamin D stores exhibited better functional outcome, as indicated by higher Knee Society Scores (KSS) at the 6 month postoperative evaluation. The 6-month KSS for the subjects in the vitamin D sufficiency was 90.3 ± 9.5 while that of the vitamin D insufficiency was 82.5 ± 13.4; $p < 0.01$. There was also a greater improvement in functional scores on the dichotomous WOMAC pain subscale [20]. This can mean that normal Vitamin D helps to promote not only physical health but also pain control and joint mobility. This study also revealed that post TKA patients who had ample amounts of vitamin D required lesser number of days to gain back their strength in the quadriceps muscles that is an essential component of the focus in the recovery process following TKA. The increase in the quadriceps strength at 3 months for with vitamin D sufficient patients was 56.4 ± 9.3 Kg compared to with vitamin D deficient patients 49.1 ± 7.6Kg ($p = 0.03$). Likewise the timed up and go test which measures mobility and function demonstrated that vitamin D adequate patient's mean TUG was 12.6 ± 3.2 seconds as against the vitamin D deficient population which was 14.5 ± 4.1 seconds, $p = 0.02$. These results much enrich our understanding of muscles, and vitamin D as muscles strength, balance, and coordination are pertinent to vitamin D. Rehabilitation outcomes might thus be determined by patients' vitamin D status, because sufficient vitamin D can help patients return to their feet and regain muscle mass faster after surgery. The study also did not reveal any differences between vitamin D sufficiency and deficiency concerning DVT or postoperative bleeding; nevertheless, the general incidence of complications was lower in the vitamin D-sufficient group [22]. This could be an indication that vitamin D has immunomodulatory, wound healing and muscle strengthening properties which help to prevent complications. Nevertheless, the study enrollment may have been insufficient and the rate of occurrence of these complications in this group of patients might not be frequent enough to support concrete conclusion about benefits of vitamin D supplementation in these outcomes. There are however several limitations, to this research as follows: First, the present study was conducted in a single center, and the patient sample was limited in size.

Conclusion

It is concluded that vitamin D deficiency is highly prevalent in patients undergoing total knee arthroplasty and is associated with increased postoperative complications, including surgical site infections and delayed functional recovery. Preoperative vitamin D supplementation significantly improves serum levels, leading to better outcomes in terms of infection rates, pain management, and

rehabilitation. Routine screening and supplementation of vitamin D in TKA patients may enhance recovery and reduce complications.

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