Original Research Paper

Volume - 16 | Issue - 09 | September - 2026 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Orthopaedics

THE IMPACT OF VITAMIN D STATUS ON CLINICAL AND FUNCTIONAL OUTCOMES FOLLOWING TOTAL KNEE ARTHROPLASTY

Dr. Suryawanshi Ravikumar

Dr. Hamlipur Anusha

ABSTRACT Bone metabolism, muscle function, and immunological modulation are all significantly impacted by vitamin D. Its effects on osteoporosis and fracture healing are well-established, but its impact on outcomes after total knee arthroplasty (TKA) is yet unknown. The prevalence of vitamin D insufficiency was very high among TKA patients. Periprosthetic joint infection (PJI), a higher likelihood of revision, and worse functional outcomes, such as lower Knee Society Scores, have all been linked to reduced vitamin D levels. Additionally, several research found links to decreased implant survival, longer hospital stays, and more postoperative problems. However, results varied throughout research, in part due to variations in vitamin D insufficiency thresholds and replacement regimens. Infection, revision risk, and postoperative recovery are among the clinical and functional outcomes following total knee arthroplasty (TKA) that may be significantly influenced by vitamin D insufficiency. Therefore, preoperative evaluation and treatment of vitamin D insufficiency may be advantageous. However, additional randomized controlled trials and multicenter prospective investigations are needed to validate these correlations and create standardized vitamin D thresholds and supplementation plans.

KEYWORDS : Vitamin D deficiency; total knee arthroplasty; total knee replacement; knee osteoarthritis; periprosthetic joint infection; postoperative complications; revision arthroplasty; Knee Society Score.

INTRODUCTION

Total knee arthroplasty (TKA) is an established and effective treatment for end-stage knee osteoarthritis (OA); however, approximately 10% of patients remain dissatisfied despite technically successful surgery [1]. Postoperative satisfaction and functional recovery are influenced by surgical factors, implant alignment, patient characteristics, and postoperative complications [2]. Although personalized alignment strategies, including kinematic and functional alignment, have gained increasing interest, their long-term clinical superiority remains uncertain [3].Periprosthetic joint infection (PJI), aseptic loosening, and instability remain major causes of failure and revision following TKA [4]. Consequently, increasing attention has been directed toward potentially modifiable biological factors that may influence postoperative recovery and complications.

Vitamin D is essential for calcium and phosphate homeostasis, bone metabolism, and musculoskeletal function. Increasing evidence also suggests that vitamin D has immunomodulatory and anti-inflammatory effects that may be relevant to OA and postoperative recovery [5]. OA is now recognized as a whole-joint disease involving cartilage, subchondral bone, synovium, and inflammatory pathways. Vitamin D receptors are expressed in several joint tissues, and vitamin D may modulate inflammatory mediators involved in cartilage degradation and disease progression [6].Vitamin D deficiency is common among patients undergoing arthroplasty and has been associated with poorer postoperative functional outcomes. Studies have reported associations between low preoperative vitamin D levels and impaired early functional recovery following TKA [7]. A recent systematic review and meta-analysis further suggested that vitamin D deficiency may be associated with poorer outcomes and longer hospital stay after TKA, although considerable heterogeneity exists among studies and the benefits of routine supplementation remain uncertain [8].Therefore, perioperative vitamin D status may represent a potentially modifiable patient-related factor influencing recovery after TKA.

Clinical And Functional Outcomes Following Tka In Relation To Blood Vitamin D Concentration

Table 1. Summary Of Studies Evaluating The Association Between Vitamin D Status And Outcomes After Total Knee Arthroplasty

Study	Country	n	Vitamin D deficiency threshold	Deficiency (%)	Main outcome measure	Key finding
Hwang et al. [15]	South Korea	704	<20 ng/mL	79.0	VAS; KSS; WOMAC	No significant postoperative functional differences
Jansen et al. [10]	UK	139	<16 ng/mL	23.7	KSS	Lower preoperative KSS; no significant difference at 6 months
Jansen et al. [9]	UK	138	≤16 ng/mL	24	WOMAC; hospital stay	Longer hospital stay and worse 8-year WOMAC outcomes
Khan et al. [17]	Pakistan	110	<30 ng/mL	50	KSS; functional tests	Deficiency associated with poorer 3-month functional outcomes
Lee et al. [16]	China	191	<20 ng/mL	7.5–36.4	EQ-5D; WOMAC	Hypovitaminosis D associated with poorer preoperative function and possible persistent pain
Maniar et al. [14]	India	120	<30 ng/mL	53.3	WOMAC; SF-36; KSS	Worse preoperative function; no difference at 3 months
Morrison et al. [11]	UK	413	N/A	N/A	Womac; Inflammatory Markers	Reduced IL-6:IL-10 ratio; no functional benefit
Shin et al. [13]	South Korea	92	<12 ng/mL	49.4	KSS; functional tests	Deficiency associated with poorer early functional recovery
Weintraub et al. [12]	USA	107	N/A	N/A	KSS; TUGT	No significant improvement with vitamin D3 supplementation

Table 2. Summary of studies evaluating Vitamin D and complications after TKA

Study	Country	n	Vitamin D levels threshold	% of patients with vitamin D deeficiency	Main outcome	Key finding
Shin et al. [13]	USA	6593	<20	13.2	Complications	↑ SSI, explantation, stiffness, DVT, CV events
Maniar et al. [14]	Germany	109	<20	64	PJI/loosening	Lower vitamin D associated with PJI
Mouli et al. [18]	USA	174	<30	100	LOS/complications	Supplementation corrected deficiency
Arshi et al. [19]	USA	10,000	<20	—	PJI	Vitamin D repletion was cost-effective

Birinci et al. [20]	Turkey	1080	<30	—†	Complications	Supplementation reduced wound complications
Kong et al. [21]	South Korea	142,147	—	—	Revision/survival	>1-year Ca/Vit D use reduced revision risk
Zajonz et al. [22]	Germany	240	<20	46–57	PJI	Deficiency common in PJI
Maier et al. [23]	Germany	190	<20	52–86	PJI/loosening	Greater deficiency in PJI and loosening
Hegde et al. [24]	USA	6593	<20	13.2	Complications	Deficiency independently increased complications
Pilc et al. [25]	USA	8780	<30	50	PJI/revision	No significant association with major complications

Clinical And Functional Outcomes

Nine studies evaluating the association between vitamin D status and clinical and functional outcomes after TKA were included [16–24]. Study populations ranged from 87 to 176 patients, with vitamin D deficiency defined using thresholds ranging from <12 to <30 ng/mL. The prevalence of deficiency ranged from 23.7% to 80%. Overall, six of nine studies reported poorer postoperative outcomes in vitamin D-deficient patients, particularly regarding KSS and WOMAC scores [9-17]. However, findings were heterogeneous, with several studies demonstrating no significant differences after surgery.

Complications

Twelve studies evaluated the association between vitamin D status and postoperative complications [18-25]. Sample sizes ranged from 109 to 142,147 patients, and vitamin D deficiency was generally defined as <20 or <30 ng/mL, with prevalence ranging from 13.2% to 100%. Ten of the 12 studies reported an adverse association between vitamin D deficiency and postoperative outcomes, including higher rates of SSI, PJI, wound complications, stiffness, explantation, and DVT [23,24]. Lower vitamin D levels were also reported among patients with PJI and those undergoing revision arthroplasty. In contrast, two studies found no significant association between vitamin D status and aseptic loosening [22-25] while one study found no difference in periprosthetic fracture risk between vitamin D-deficient and sufficient patients [25]. Overall, the evidence suggests that vitamin D deficiency may be associated with poorer functional recovery and a higher risk of selected postoperative complications, although substantial heterogeneity exists among studies.

DISCUSSION

The available evidence suggests that vitamin D deficiency may adversely affect outcomes following total knee arthroplasty (TKA). Several studies reported poorer functional recovery, longer hospital stays, and increased postoperative pain in vitamin D-deficient patients. Jansen et al. found an approximately 1-day longer hospital stay, while Shin et al. reported significantly lower postoperative functional KSS scores in deficient patients (67.2 vs. 73.4, $p = 0.031$) [9,13]. Kahn et al. also demonstrated poorer functional KSS and performance measures in vitamin D-insufficient patients [17]. However, other studies found no significant differences in WOMAC, KSS, pain, or short-term functional outcomes, indicating that threlationship remains inconsistent [14.15].

Vitamin D deficiency appears to have a stronger association with postoperative complications. Hegde et al. reported increased risks of surgical-site infection (OR 1.76), prosthesis explantation/PJI (OR 2.97), postoperative stiffness requiring manipulation (OR 1.69), DVT (OR 1.80), and cerebrovascular events (OR 1.73) [24]. Patients with PJI also had significantly lower vitamin D levels than patients undergoing primary arthroplasty [22]. Nevertheless, evidence regarding aseptic loosening and periprosthetic fractures remains inconclusive [21].

Preoperative vitamin D supplementation may provide additional benefits. Birinci et al. reported reductions in overall complications, superficial wound infections, and cellulitis following supplementation, although PJI, mortality, and readmission rates were unchanged [20]. In a large cohort, Kong et al. found that calcium and vitamin D supplementation was associated with better implant survival and lower revision rates . Vitamin D repletion has also been reported to be cost-effective for reducing PJI risk [19].

Overall, vitamin D deficiency is common among patients undergoing TKA and may contribute to poorer functional outcomes and postoperative complications, particularly infection and stiffness. Preoperative assessment and correction of deficiency may therefore be beneficial. However, differences in vitamin D cut-off values and supplementation protocols limit comparisons between studies. Further well-designed randomized trials are needed to establish standardized thresholds and confirm the clinical benefit of vitamin D optimization before TKA.

CONCLUSIONS

Vitamin D deficiency is common among patients undergoing primary TKA and may negatively affect postoperative outcomes. Low vitamin D levels are associated with poorer functional outcomes, higher risks of infection and wound complications, and other postoperative complications. Therefore, preoperative assessment and correction of vitamin D deficiency may be a simple, safe, and cost-effective strategy to optimize patients before TKA. However, the evidence remains partly inconsistent, largely due to differences in vitamin D thresholds and supplementation protocols. Further prospective studies are needed to establish standardized vitamin D targets and treatment strategies.

REFERENCES

1. DeFrance, M.J.; Scuderi, G.R. Are 20% of Patients Actually Dissatisfied Following Total Knee Arthroplasty? A Systematic Review of the Literature. J. Arthroplast. 2023, 38, 594–599. [CrossRef] [PubMed]
2. Miura, T.; Yamamoto, N.; Shiroshita, A.; Tsuge, T.; Saitsu, A.; Yoshitani, J.; Nakao, S.; Takami, K. Comparison of Implant Placement Accuracy Between Manual, Robot-Assisted, Computer-Navigated, Augmented Reality Navigated, Patient-Specific Instrumentation, and Accelerometer Navigated Total Hip Arthroplasty: A Systematic Review and Network Meta-Analysis. JBJS Rev. 2024, 12, e24. [CrossRef] [PubMed]
3. Sveikata, T.; Porvaneckas, N.; Kanopa, P.; Molyte, A.; Klimas, D.; Uvarovas, V.; Venalis, A. Age, Sex, Body Mass Index, Education, and Social Support Influence Functional Results After Total Knee Arthroplasty. Geriatr. Orthop. Surg. Rehabil. 2017, 8, 71–77. [CrossRef]
4. Ma, L.; Yu, X.; Weng, X.; Lin, J.; Qian, W.; Huang, Y. Obesity paradox among patients undergoing total knee arthroplasty: A retrospective cohort study. BMC Surg. 2022, 22, 373. [CrossRef]
5. Rosemont, I. American Joint Replacement Registry (AJRR): 2023 Annual Report; American Academy of Orthopaedic Surgeons (AAOS): Rosemont, IL, USA, 2023.
6. Maier, G.S.; Weissenberger, M.; Rudert, M.; Roth, K.E.; Horas, K. The role of vitamin D and vitamin D deficiency in orthopaedics and traumatology-a narrative overview of the literature. Ann. Transl. Med. 2021, 9, 942. [CrossRef]
7. Chen, D.; Shen, J.; Zhao, W.; Wang, T.; Han, L.; Hamilton, J.L.; Im, H.J. Osteoarthritis: Toward a comprehensive understanding of pathological mechanism. Bone Res. 2017, 5, 16044. [CrossRef]
8. Gatt, T.; Grech, A.; Arshad, H. The Effect of Vitamin D Supplementation for Bone Healing in Fracture Patients: A Systematic Review. Adv. Orthop. 2023, 2023, 6236045. [CrossRef]
9. Jansen, J.; Tahmassebi, J.; Haddad, F.S. Vitamin D Deficiency Is Associated With Longer Hospital Stay And Lower Functional outcome After Total Knee Arthroplasty. Acta Orthop. Belg. 2017, 83, 664–670.
10. Jansen, J.A.; Haddad, F.S. High prevalence of vitamin D deficiency in elderly patients with advanced osteoarthritis scheduled for total knee replacement associated with poorer preoperative functional state. Ann. R. Coll. Surg. Engl. 2013, 95, 569–572. [CrossRef]
11. Morrison, R.J.M.; Fishley, W.G.; Rankin, K.S.; Reed, M.R. The effect of vitamin D supplementation on outcomes following total hip or knee arthroplasty surgery: A rapid systematic review of current evidence. EFORT Open Rev. 2022, 7, 305–311. [CrossRef]
12. Weintraub, M.T.; Guntin, J.; Yang, J.; DeBenedetti, A.; Karas, V.; Della Valle, C.J.; Nam, D. Vitamin D(3) Supplementation Prior to Total Knee Arthroplasty: A Randomized Controlled Trial. J. Arthroplast. 2023, 38, S114–S119. [CrossRef] [PubMed]
13. Shin, K.Y.; Park, K.K.; Moon, S.H.; Yang, I.H.; Choi, H.J.; Lee, W.S. Vitamin D deficiency adversely affects early post-operative functional outcomes after total knee arthroplasty. Knee Surg. Sports Traumatol. Arthrosc. 2017, 25, 3424–3430. [CrossRef]
14. Maniar, R.N.; Patil, A.M.; Maniar, A.R.; Gangaraju, B.; Singh, J. Effect of Preoperative Vitamin D Levels on Functional Performance after Total Knee Arthroplasty. Clin. Orthop. Surg. 2016, 8, 153–156. [CrossRef] [PubMed]
15. Hwang, I.Y.; Park, K.B.; Chang, S.W.; Cho, S.D.; Youm, Y.S. Preoperative vitamin D level does not affect the short-term functional outcome after total knee arthroplasty in elderly women. Knee Surg. Relat. Res. 2020, 32, 30. [CrossRef]
16. Lee, A.; Chan, S.K.C.; Samy, W.; Chiu, C.H.; Gin, T. Effect of Hypovitaminosis D on Postoperative Pain Outcomes and Short-Term Health-Related Quality of Life After Knee Arthroplasty: A Cohort Study. Medicine 2015, 94, e1812. [CrossRef]
17. Khan, J.; Ahmed, R.; Akhtar, R. Effect of pre-operative serum vitamin-D levels on post-operative outcome in total knee arthroplasty. J. Postgrad. Med. Inst. 2019, 33, 74–78.
18. Mouli, V.H.; Schudrowitz, N.; Carrera, C.X.; Uzosike, A.C.; Fitz, W.; Rajaee, S.S. High-Dose Vitamin D Supplementation Can Correct Hypovitaminosis D Prior to Total Knee Arthroplasty. J. Arthroplast. 2022, 37, 274–278. [CrossRef] [PubMed]
19. Arshi, A.; Shieh, A.; Adams, J.S.; Bernthal, N.M.; Zeegen, E.N.; Sassoon, A.A. Preoperative Vitamin D Repletion in Total Knee Arthroplasty: A Cost-Effectiveness Model. J. Arthroplast. 2020, 35, 1379–1383. [CrossRef]
20. Birinci, M.; Hakyemez, O.S.; Geckalan, M.A.; Mutlu, M.; Yildiz, F.; Bilgen, O.F.; Azboy, I. Effect of Vitamin D Deficiency on Periprosthetic Joint Infection and Complications After Primary Total Joint Arthroplasty. J. Arthroplast. 2024, 39, S151–S157. [CrossRef]
21. Kong, Y.; Han, M.; Lee, M.; Kim, E.H.; Jung, I.; Park, K.K. The Association of Calcium and Vitamin D Use With Implant Survival of Total Knee Arthroplasty: A Nationwide Population-Based Cohort Study. J. Arthroplast. 2021, 36, 542–549 e543. [CrossRef]
22. Zajonz, D.; Prager, F.; Edel, M.; Mobius, R.; Daikos, A.; Fakler, J.K.; Josten, C.; Kratzsch, J.; Roth, A. The significance of the vitamin D metabolism in the development of periprosthetic infections after THA and TKA: A prospective matched-pair analysis of 240 patients. Clin. Interv. Aging 2018, 13, 1429–1435. [CrossRef]
23. Maier, G.S.; Horas, K.; Seeger, J.B.; Roth, K.E.; Kurth, A.A.; Maus, U. Is there an association between periprosthetic joint infection and low vitamin D levels? Int. Orthop. 2014, 38, 1499–1504. [CrossRef]
24. Hegde, V.; Arshi, A.; Wang, C.; Buser, Z.; Wang, J.C.; Jensen, A.R.; Adams, J.S.; Zeegen, E.N.; Bernthal, N.M. Preoperative Vitamin D Deficiency Is Associated With Higher Postoperative Complication Rates in Total Knee Arthroplasty. Orthopedics 2018, 41, e489–e495. [CrossRef]
25. Pilc, E.M.; Zhao, A.Y.; Kubsad, S.; Thakkar, S.; Patel, N.K. Vitamin D deficiency and periprosthetic fractures. J. Clin. Orthop. Trauma 2025, 70, 103164. [CrossRef] [PubMed]