

Muscle Matters in Knee Surgery Rehabilitation: Translational and Clinical Insights into Fall Risk

Francesco Pegreffi^{1,2}, Gabriela Graziani³, Laura Saldana Quero⁴, Maria Tiziana di Leo², Arcangelo Russo⁵, Jean Calleja-Agius⁶, Nicola Veronese⁷

¹ Department of Medicine and Surgery, School of Medicine and Surgery, University of Enna "Kore", 94100 Enna, Italy ² Recovery and Functional Rehabilitation Unit, Umberto I Hospital, 94100 Enna, Italy ³ University Rome San Raffaele, Rome, IT ⁴ Hospital Universitario La Paz, Madrid, SP ⁵ Orthopaedic and Traumatology Unit, Umberto I Hospital, 94100 Enna, Italy ⁶ Department of Anatomy, Faculty of Medicine and Surgery, University of Malta, Malta. ⁷ Saint Camillus International University of Health Sciences, Rome, Italy

Presenting Author: francesco.pegreffi@unikore.it

Disclosures: Francesco Pegreffi (N), Gabriela Graziani (N), Laura Saldana Quero (N), Maria Tiziana di Leo (N), Arcangelo Russo (N), Jean Calleja-Agius (N), Nicola Veronese (N)

INTRODUCTION: Muscle health is increasingly recognized as a cornerstone of clinical outcomes, especially in orthopedic surgery and rehabilitation. In patients undergoing total knee arthroplasty (TKA), quadriceps strength is essential not only for mobilizing the prosthesis but also for maintaining balance and preventing falls during gait. Vitamin D, beyond its role in bone metabolism, is critically involved in muscle function, neuromuscular coordination, and proprioception. Deficiency may therefore exacerbate postoperative weakness and instability, increasing fall risk during early rehabilitation.

This study examines the prevalence of vitamin D deficiency in TKA patients and investigates the relationship between postoperative vitamin D levels, preoperative supplementation, and fall risk during early rehabilitation.

METHODS: A cross-sectional study of 40 TKA patients was conducted. Patients were categorized into four groups according to serum vitamin D levels, and fall risk was assessed using the Conley Scale. As part of routine clinical practice, a blood sample was obtained at admission to the rehabilitation unit to measure serum vitamin D concentrations. Statistical analyses included two-sample t-tests and Pearson's correlation.

RESULTS SECTION: A total of 40 patients undergoing TKA were included in the study (mean age: 74 ± 6 years, BMI: 24 ± 1). Patients were stratified into four groups according to serum vitamin D levels (<10 - Group 1, 10–20 - Group 2, 20–30 - Group 3, and >30 - Group 4 ng/mL). Fall risk, assessed with the Conley Scale, decreased progressively with increasing vitamin D levels, with mean scores of 3.50 ± 0.76 in the group with <10 ng/mL, 2.73 ± 0.65 in the group with 10–20 ng/mL, 1.07 ± 0.45 in the group with 20–30 ng/mL, and 0.50 ± 0.52 in the group with >30 ng/mL.

Patients who received preoperative vitamin D supplementation (n = 18) showed significantly higher serum vitamin D levels (28.6 ± 6.2 ng/mL) compared with those without supplementation (n = 22; 14.8 ± 5.4 ng/mL, *p* = 0.04). Fall risk scores, assessed with the Conley Scale, were lower in the supplemented group (1.02 ± 0.61) compared with the non-supplemented group (2.95 ± 0.82), and this difference reached statistical significance (*p* = 0.049).

Moreover, when vitamin D was analyzed as a continuous variable, Pearson's correlation demonstrated a strong and significant negative association with Conley scores (*r* = -0.837, *p* < 0.001), indicating that higher serum vitamin D concentrations were consistently associated with reduced fall risk during early rehabilitation (Fig. 1).

DISCUSSION: Identifying patients at increased risk of falling remains a critical challenge in the context of postoperative rehabilitation following total knee arthroplasty (TKA). Individuals with advanced knee osteoarthritis frequently present with pre-existing quadriceps weakness, which is further exacerbated by surgical trauma and the immediate postoperative recovery period. This cumulative impairment may substantially contribute to instability and elevate the risk of falls during early rehabilitation. Vitamin D deficiency is common in older adults and has been consistently associated with impaired muscle function, reduced balance, and increased fall risk in both community and clinical settings. In the present cohort, a considerable proportion of patients demonstrated suboptimal vitamin D levels, supporting the notion that deficiency represents a prevalent and clinically relevant issue in the TKA population. Although our study did not directly assess quadriceps strength, previous research has established its central role in gait stability, suggesting that vitamin D deficiency and postoperative muscle weakness may act synergistically to increase fall risk. This study adopted a translational approach by combining a biological marker, serum vitamin D concentration, with a validated clinical measure of fall risk, the Conley Scale. This integration underscores the potential utility of incorporating both simple laboratory assessment and structured risk stratification into perioperative practice. Moreover, a consistent trend was observed whereby higher vitamin D levels and preoperative supplementation were associated with lower fall risk scores. The strong inverse correlation identified further reinforces the biological plausibility of this relationship, even if definitive conclusions cannot be drawn on the basis of the current sample size. Taken together, these results highlight the potential role of vitamin D optimization, acting through its effects on skeletal muscle, in improving safety and functional recovery following TKA. Preoperative assessment and correction of vitamin D deficiency may represent a simple, low-cost intervention to enhance rehabilitation outcomes. Nevertheless, further randomized controlled trials with larger cohorts are warranted to clarify the causal relationship, establish clinically meaningful thresholds, and inform guidelines for the systematic integration of vitamin D assessment and supplementation into orthopedic practice. Such trials should also incorporate quantitative assessments of muscle function, thereby providing a more comprehensive understanding of the mechanistic link between vitamin D status, muscle performance, and postoperative recovery.

SIGNIFICANCE/CLINICAL RELEVANCE: By linking serum vitamin D levels with a validated clinical fall risk score, this study provides translational evidence that optimizing muscle health may improve safety and functional recovery in patients undergoing knee surgery rehabilitation. Skeletal muscle is not merely an accessory to mobility but a critical organ of health, directly influencing strength, balance, and postoperative recovery, and thus must be regarded as a central determinant of clinical outcomes.

REFERENCES: (References are Optional)

ACKNOWLEDGEMENTS: (Acknowledgements are Optional)

IMAGES AND TABLES: Figure 1: Bar Plot: Represents the percentage of patients with (1) and without (2) preoperative Vitamin D supplementation.

Dashed Purple Line: Represents the average Conley Scale score for each group, plotted on a secondary Y-axis for better clarity.

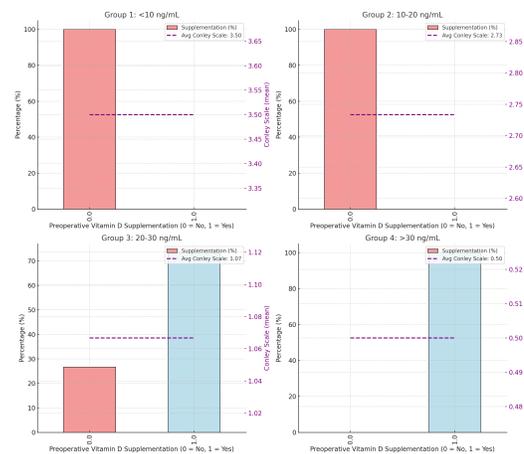


Figure 1