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Impact of Vitamin D Deficiency on Healing and Functional Recovery Following Intertrochanteric Femur Fracture Surgery

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ABSTRACT:

Intertrochanteric femur fractures are frequently encountered in older adults and can substantially affect mobility, independence, and quality of life. Vitamin D is essential for maintaining calcium and phosphate balance, bone mineralization, skeletal integrity, and muscle function. This review evaluates the potential influence of vitamin D deficiency on fracture healing and functional recovery following surgical management of intertrochanteric femur fractures. Low vitamin D status is commonly reported among patients with hip fractures, particularly in older individuals with limited mobility, inadequate dietary intake, reduced sunlight exposure, and multiple comorbidities. Evidence suggests that vitamin D deficiency may contribute to reduced muscle strength, impaired physical performance, and difficulties during postoperative rehabilitation. However, its direct association with radiological fracture healing remains uncertain. Although vitamin D participates in bone remodeling and mineralization, existing clinical studies have not consistently established that deficiency independently results in delayed union or non-union. Similarly, supplementation may benefit musculoskeletal health, but evidence for improved fracture union and functional outcomes is variable. Therefore, vitamin D assessment and correction should be incorporated into comprehensive postoperative care together with appropriate fixation, adequate nutrition, calcium intake, early mobilization, and structured rehabilitation. Further prospective studies are needed to clarify the clinical significance of vitamin D status and determine the optimal supplementation strategy after intertrochanteric fracture surgery.

KEY WORDS: Vitamin D deficiency, Intertrochanteric femur fracture, Hip fracture, Fracture healing, Functional recovery, Bone mineralization, Muscle strength, Postoperative rehabilitation, Vitamin D supplementation, Orthopedic surgery.

INTRODUCTION:

Intertrochanteric femur fractures are among the common fractures encountered in older adults, particularly in individuals with reduced bone strength and a higher risk of falls. These fractures can substantially affect mobility, independence and quality of life. Surgical fixation is commonly undertaken to stabilize the fracture and facilitate early mobilization. Despite advances in fixation techniques and postoperative rehabilitation, recovery may vary considerably between patients. Age, comorbidities, nutritional status, bone quality, fracture characteristics and postoperative complications can all influence the outcome [1][2]. Vitamin D is an important micronutrient involved in skeletal and muscular health. It contributes to the regulation of calcium and phosphate concentrations, supports bone mineralization and has physiological effects on skeletal muscle. Vitamin D deficiency is frequently observed among individuals with hip and other fragility fractures. A systematic review and meta-analysis reported a high prevalence of inadequate vitamin D status among fracture patients, emphasizing the importance of considering vitamin D status in this population . The possible relationship between vitamin D and fracture recovery has attracted increasing clinical interest. Adequate vitamin D may support the biological processes involved in bone repair, while deficiency may be associated with impaired muscle performance and reduced physical function [4][6] . However, clinical studies have not produced completely consistent findings regarding the effect of vitamin D deficiency on radiological fracture healing [4][5]. The purpose of this review is to examine the available evidence concerning vitamin D deficiency and recovery following intertrochanteric femur fracture surgery, with particular attention to bone healing, functional recovery, rehabilitation and the potential benefits of vitamin D supplementation.

VITAMIN D DEFICIENCY IN PATIENTS WITH INTERTROCHANTERIC AND HIP FRACTURES

Vitamin D status is most commonly evaluated by measuring serum 25-hydroxyvitamin D [25(OH)D], which represents the major circulating form of vitamin D. Older adults are particularly vulnerable to low vitamin D levels because vitamin D production through the skin decreases with age. Limited

outdoor activity, inadequate dietary intake, reduced mobility and multiple chronic illnesses may further contribute to deficiency [2][3]. Vitamin D deficiency is common among patients presenting with hip fractures. Sprague et al. reported a high prevalence of hypovitaminosis D in fracture patients and highlighted the frequent occurrence of low serum 25(OH)D concentrations in this clinical population [3]. This finding is important because many patients with hip fractures already have reduced bone density and impaired physical reserve before sustaining the fracture. Several investigations have examined the relationship between vitamin D concentration and recovery after hip fracture. A study involving 493 patients receiving post-acute rehabilitation reported an association between vitamin D status, muscle strength and functional outcomes [6]. Similarly, a prospective study involving 1,350 hip fracture inpatients evaluated vitamin D status in relation to functional recovery and reported differences in functional outcomes according to vitamin D categories [7]. Evidence specifically involving intertrochanteric fractures is particularly relevant. In a study of 171 patients who underwent surgical treatment for intertrochanteric hip fractures, vitamin D status was examined in relation to subsequent functional improvement. Functional ability was assessed using the Modified Barthel Index at different stages of follow-up [9]

These findings demonstrate that low vitamin D status is common in hip fracture patients; however, the presence of deficiency does not necessarily establish a direct causal relationship with poor fracture healing or functional recovery.

ROLE OF VITAMIN D IN BONE HEALTH AND FRACTURE HEALING

Vitamin D contributes to skeletal health by helping maintain calcium and phosphate availability, both of which are essential for normal bone mineralization. Vitamin D also participates in biological signaling involving bone-forming and bone-resorbing cells. Through these actions, it contributes to the maintenance and remodeling of skeletal tissue [4][10]. Fracture healing is a complex biological process involving several overlapping stages. Initially, an inflammatory response occurs at the fracture site. This is followed by formation of a soft callus, development and mineralization of a hard callus, and finally remodeling of the newly formed bone. Successful progression through these stages requires adequate cellular activity, blood supply, mineral availability and mechanical stability [4]. Vitamin D may contribute to fracture repair by supporting the availability of calcium and phosphate required for mineralization. It may also influence osteoblast and osteoclast activity, thereby participating in the formation and remodeling of bone. Vitamin D receptors are expressed in cells involved in skeletal and muscular function, suggesting that its effects extend beyond mineral metabolism [4][10][11]. Vitamin D is also relevant to skeletal muscle. Adequate vitamin D status may support muscle performance, whereas deficiency has been associated with reduced muscle strength and physical performance. This is particularly important after hip fracture because muscle weakness can interfere with rehabilitation, walking and independent activities [6][11]. Although these biological mechanisms provide a rationale for an association between vitamin D and fracture recovery, laboratory and physiological plausibility should not be interpreted as proof of a clinically significant improvement in fracture union. Human studies have produced variable results, and further clinical research is needed [4][5].

IMPACT OF VITAMIN D DEFICIENCY ON POSTOPERATIVE FRACTURE HEALING

Theoretically, vitamin D deficiency may adversely affect fracture healing by interfering with normal mineral metabolism and bone remodeling. Inadequate vitamin D can reduce intestinal calcium absorption and may result in compensatory changes in parathyroid hormone activity. Prolonged disturbances in calcium-phosphate regulation can adversely affect skeletal health [4][10]. Following intertrochanteric fracture fixation, radiological healing depends on adequate biological repair as well as appropriate mechanical stabilization. Vitamin D may therefore represent one of several nutritional and metabolic factors that contribute to successful healing. However, available clinical evidence does not consistently demonstrate that vitamin D deficiency causes delayed union or non-union. A systematic review examining vitamin D and human fracture healing found considerable variation among existing studies and concluded that the clinical evidence was insufficient to establish a clear relationship between vitamin D status and fracture-healing outcomes [4]. Evidence concerning vitamin D supplementation is similarly mixed. A systematic review published in 2023 examined studies evaluating vitamin D supplementation in fracture patients. Although individual studies reported potentially favorable outcomes, the overall evidence did not consistently demonstrate improved radiological union following vitamin D supplementation alone [5].

This distinction is important when interpreting the literature. Vitamin D deficiency is biologically relevant to bone metabolism, but it should not automatically be regarded as an independent cause of delayed fracture union. Fracture healing is influenced by multiple factors, including age, fracture pattern, fixation stability, blood supply, osteoporosis, nutritional status, smoking, diabetes and other comorbid conditions.

IMPACT OF VITAMIN D DEFICIENCY ON FUNCTIONAL RECOVERY AND REHABILITATION

vitamin D deficiency may affect postoperative recovery through its association with reduced muscle strength, mobility and physical performance. Studies in hip-fracture patients have reported associations between lower vitamin D levels and poorer functional outcomes measured by the Barthel Index and Functional Independence Measure (FIM) [6][7]. However, findings are inconsistent, as some studies of surgically treated intertrochanteric fractures have not demonstrated a significant effect on functional recovery [1]. Therefore, vitamin D status may be one of several factors influencing rehabilitation, alongside age, comorbidities, nutritional status and rehabilitation intensity [8]

VITAMIN D SUPPLEMENTATION AND CLINICAL OUTCOMES

Vitamin D supplementation is commonly considered for correcting deficiency in patients with hip fractures. Supplementation may support bone and muscle health, but evidence regarding its direct effect on fracture union and functional recovery remains inconsistent [5]. Clinical studies suggest that supplementation should be combined with appropriate calcium intake, early mobilization and structured rehabilitation rather than being considered an isolated treatment [5][10]. Further studies are required to determine the optimal dose, duration and clinical benefits of vitamin D supplementation after intertrochanteric fracture surgery

DISCUSSION

Vitamin D deficiency is common in patients with hip fractures and may be associated with poorer muscle strength, mobility and functional recovery [1][6-8]. However, evidence regarding its direct effect on fracture healing and the benefits of supplementation remains inconsistent [4][5]. Therefore, vitamin D status should be considered alongside surgical stability, nutrition and rehabilitation when managing intertrochanteric fractures. Further studies are needed to establish its exact role in healing and functional recovery

CONCLUSION

Vitamin D deficiency is common in patients with intertrochanteric fractures and may negatively influence bone healing, muscle strength and functional recovery. However, current evidence remains inconsistent. Early identification and correction of vitamin D deficiency, along with appropriate surgery and rehabilitation, may support better recovery. Further studies are needed to establish its specific effect on fracture healing and functional.

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