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Original Research Article

Comparative analysis of teriparatide and calcium supplementation in post-surgery fracture healing among osteoporotic patients

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ABSTRACT

Background: Osteoporotic fractures pose a significant clinical challenge due to delayed healing, prolonged immobilization and increased morbidity. Teriparatide, an anabolic agent, has shown promise in enhancing fracture healing by stimulating osteoblastic activity. This study aimed to compare the efficacy of teriparatide versus calcium carbonate in promoting fracture healing among osteoporotic patients following surgical fixation.
Methods: This retrospective cohort study was conducted at Marble City Hospital, Kishangarh, Rajasthan, from March 2023 to February 2025. A total of 260 patients diagnosed with osteoporosis and undergoing surgical fracture fixation were enrolled. Patients were divided into two groups: Group A (teriparatide, n=130) and Group B (calcium carbonate, n=130). Fracture healing was assessed by measuring cortical bridging time through radiographs, with gender distribution and fracture types analyzed using chi-square and t-tests.
Results: Group A (Teriparatide) achieved significantly faster fracture healing, with a mean healing time of 12.09±1.50 weeks, compared to Group B (Calcium carbonate), which required 14.01±1.95 weeks ($p<0.01$). Gender distribution was comparable between both the groups ($p=0.709$). Intertrochanteric fractures were the most prevalent (66.53%), followed by distal radius fractures (24.61%) and proximal humerus fractures (8.84%).
Conclusions: Teriparatide significantly accelerates radiographic fracture healing in osteoporotic patients compared to oral calcium carbonate supplementation. Its incorporation into post-surgical care protocols enhances recovery, reduce complications and improve patient outcomes.

Keywords: Bone union, Calcium carbonate, Fracture healing, Osteoporosis, Teriparatide

INTRODUCTION

Osteoporosis is a chronic, progressive skeletal disorder characterized by reduced bone mass and deterioration of bone micro architecture, leading to increased bone fragility and susceptibility to fractures.[1,2] It is a major global health concern, particularly among the aging population and is associated with significant morbidity, disability and healthcare costs.[3] Osteoporotic fractures, especially those involving weight-bearing bones such as the hip, vertebrae and wrist, are associated with delayed healing, prolonged immobilization and a higher risk of complications, including non-union, malunion and re-fracture.[4,5] These fractures are often termed "fragility fractures" because they occur following minimal trauma, which would not typically cause fractures in healthy bone.[6] The pathophysiology of delayed fracture healing in osteoporotic bone is complex and multifactorial. Reduced bone mineral density, impaired osteoblastic function, decreased angiogenesis and an imbalance between bone resorption and formation contribute to compromised bone regeneration.[7,8] The conventional management of osteoporotic fractures primarily involves surgical fixation, followed by calcium and vitamin D supplementation to maintain bone health. However, this standard approach has shown limited success in

enhancing the speed of fracture healing, highlighting the need for more effective therapeutic strategies.[9] Teriparatide, a recombinant form of human parathyroid hormone (PTH 1-34), has emerged as a promising therapeutic agent in the management of osteoporosis and fracture healing. It is the only approved anabolic agent for osteoporosis, directly stimulating osteoblastic activity, increasing bone formation and enhancing callus formation at fracture sites.[10]

Teriparatide's anabolic effects are achieved through its ability to activate PTH receptors on osteoblasts, promoting their proliferation, differentiation and activity, which accelerates the process of bone remodeling.[11] Numerous studies have demonstrated the efficacy of teriparatide in reducing the time to fracture healing, particularly in osteoporotic patients, making it a valuable addition to fracture management protocols.[12,13] In contrast, calcium carbonate, a commonly used supplement for maintaining bone mineral density, primarily supports bone health by providing a substrate for mineralization.[14]

Although calcium is essential for maintaining bone strength, it lacks the direct anabolic effects necessary for accelerating fracture healing. Studies have shown that while calcium supplementation may reduce the risk of minimal trauma fractures in older adults, it does not significantly enhance fracture union or accelerate the healing process in patients with established fractures.[15] This limitation underscores the need for a more targeted therapeutic approach, particularly in high-risk populations such as osteoporotic patients.

Despite the growing body of evidence supporting the use of teriparatide for fracture healing, there remains a need for well-designed comparative studies that directly evaluate its efficacy against conventional therapies, such as calcium carbonate.

This study aims to address this gap by directly comparing the efficacy of teriparatide and calcium carbonate in promoting fracture healing among osteoporotic patients following surgical fixation. By providing direct comparative data from a large patient cohort, this study seeks to offer valuable insights into the optimal management of osteoporotic fractures, with the potential to inform clinical guidelines and improve patient outcomes.

METHODS

Study type

This study was retrospective cohort study.

Study place

Study was conducted at Marble City Hospital, Kishangarh, India

Study duration

The study was conducted from March 2023 to February 2025.

A total of 260 patients diagnosed with osteoporosis and undergoing surgical fracture fixation were included in the study.

These patients were divided into two groups: Group A, consisting of 130 patients who received 20 µg of subcutaneous teriparatide (TPT 20, RPG Life Sciences) daily for 4 months and Group B, comprising 130 patients who were administered calcium carbonate 500 mg orally once daily for 4 months. Patient demographics, including age, gender and fracture type, were recorded and the primary outcome was assessed based on radiographic cortical bridging time, a measure of fracture healing.

Radiographic images were evaluated independently by two experienced musculoskeletal radiologists blinded to the treatment groups, ensuring objective assessment.

Inclusion criteria

Patients aged≥50 years, diagnosed with osteoporosis (T-score≤-2.5 on DEXA), underwent surgical fixation for fractures (intertrochanteric, distal radius or proximal humerus)

Exclusion criteria

Patients on corticosteroids, bisphosphonates or previous anabolic therapy, pathological fractures, chronic renal or hepatic disease.

Statistical analysis

Statistical analysis was performed using SPSS software (version 25.0). Continuous variables, such as healing time, were analyzed using independent t-tests, while categorical variables, including gender distribution and fracture type, were compared using chi-square tests. A p-value of<0.05 was considered statistically significant, indicating a meaningful difference between the two treatment groups. This study adhered to the Helsinki Declaration (2011), ensuring ethical integrity through informed consent, voluntary participation and data confidentiality. Institutional and departmental approvals from IRB of BSMMU were obtained before starting the research.

RESULTS

A total of 260 patients were analysed, with 130 patients in each group. Group A (Teriparatide-TPT 20, RPG Life Sciences) included 61 males (46.9%) and 69 females (53.1%), while Group B (Calcium Carbonate) included 57 males (43.8%) and 73 females (56.2%) (p=0.709) (Figure 1). Intertrochanteric fractures were the most

common (66.53%), followed by distal radius fractures (24.61%) and proximal humerus fractures (8.84%) (Figure 2).

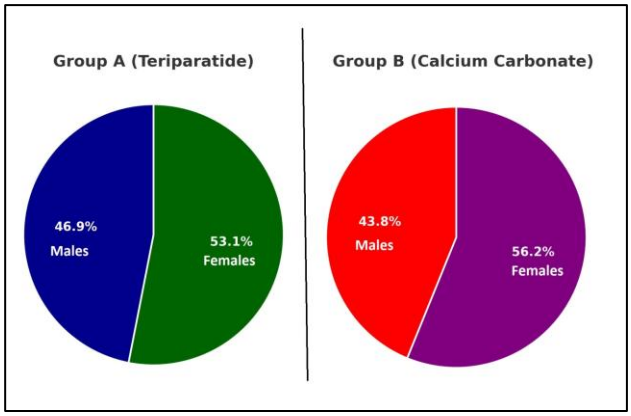

Figure 1: Gender distribution in group A and group B (p=0.709).

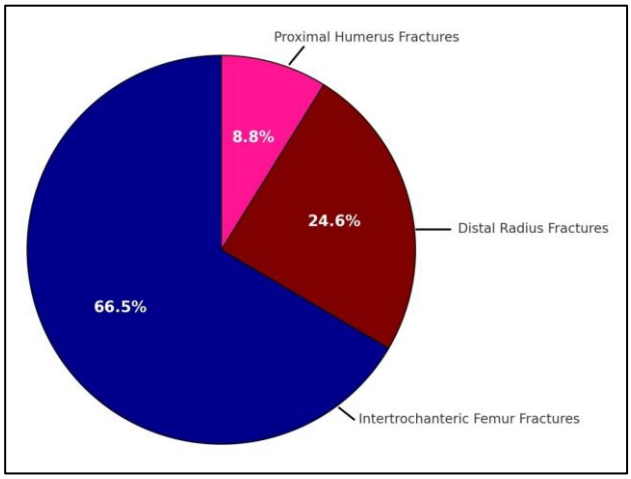

Figure 2: Fracture type distribution.

Radiographic healing time was significantly faster in Group A (teriparatide-TPT 20, RPG Lifesciences), with a total union time ranging from 10.6 to 13.6 weeks and a calculated mean union time of 12.09±1.50 weeks ($p<0.01$).

In contrast, Group B (calcium carbonate) demonstrated a total union time ranging from 11.9 to 15.8 weeks, with a mean union time of 14.01±1.95 weeks ($p<0.01$) (Table 1).

Table 1: Radiographic healing time: teriparatide vs calcium carbonate.

Treatment group	Total union time (weeks)	Mean union time (weeks)
Teriparatide (PTH 1-34)	10.6 to 13.6 ($p<0.01$)	12.09±1.50 weeks ($p<0.01$)
Calcium Carbonate	11.9 to 15.8 ($p<0.01$).	14.01±1.95 weeks ($p<0.01$)

DISCUSSION

This study demonstrates that teriparatide significantly accelerates fracture healing compared to calcium carbonate in osteoporotic patients. The anabolic effects of teriparatide, which directly stimulate osteoblast proliferation and enhance callus formation, are primarily responsible for the reduced healing time observed.[10] These findings are consistent with prior research, including studies by Miyauchi et al and Aspenberg et al, which reported faster healing with teriparatide in osteoporotic fractures.[11,12] Teriparatide's mechanism of action, which involves direct stimulation of osteoblastic activity and enhancement of callus formation, provides a clear physiological explanation for the accelerated healing observed in the present study.

In contrast, calcium carbonate, although essential for maintaining bone density, lacks the direct anabolic properties required for accelerating fracture healing.[13] Its primary role in bone health is to provide the necessary mineral substrate for bone formation, but it does not actively stimulate osteoblastic activity, which is crucial for fracture repair.[14] This difference in mechanism likely explains the slower healing observed in the calcium group, where the mean healing time was significantly longer compared to the teriparatide group. These findings emphasize the importance of choosing therapeutic agents that not only maintain bone mineral density but also directly enhance bone regeneration. The strengths of this study include a relatively large sample size (n=260), which enhances the statistical power and reliability of the findings.

Conducted in a real-world, clinical setting, this study reflects practical outcomes seen in routine orthopedic practice, enhancing the generalizability of the results. The use of objective radiographic criteria for assessing fracture healing ensures consistency and minimizes subjective interpretation. Furthermore, this study offers a direct comparison between an anabolic agent (teriparatide) and a conventional therapy (calcium carbonate), providing clear evidence of their comparative efficacy. However, the study is not without limitations. Being a retrospective cohort study, it is subject to inherent limitations, including the potential for selection bias and the inability to establish a clear causal relationship between treatment and outcomes.

Radiographic assessment, although standardized, may be subject to inter-observer variability, which can affect the consistency of results. Comparative evidence from the literature further supports the findings of this study. A systematic review by Rossi et al, confirmed the superior efficacy of teriparatide in enhancing fracture healing, particularly in osteoporotic patients with delayed union.[15] Similarly, Bhandari et al, highlighted that teriparatide significantly reduced healing time in a meta-analysis of clinical trials.[16] Aspenberg et al, also demonstrated that teriparatide accelerates healing in patients with delayed union, further supporting its role as an effective bone

anabolic agent.[17] In contrast, a study by Reid et al, demonstrated that calcium supplementation alone did not significantly impact fracture healing time, emphasizing the limited role of calcium in fracture healing without an anabolic agent.[18]

These findings collectively support the use of teriparatide as a superior therapeutic option for osteoporotic patients at high risk of delayed healing. By directly enhancing osteoblastic activity, teriparatide offers a targeted approach to accelerate fracture healing, reduce the period of immobilization and minimize the risk of complications associated with delayed union. Future research should focus on randomized controlled trials with longer follow-up periods to further validate these findings, assess functional outcomes and explore the cost-effectiveness of teriparatide compared to other therapeutic options.[15,19,20]

CONCLUSION

This study provides compelling evidence that teriparatide significantly accelerates radiographic fracture healing in osteoporotic patients compared to calcium carbonate. Its direct anabolic effects on bone enhance osteoblast proliferation, promotes callus formation and accelerates cortical bridging, resulting in faster and more efficient fracture healing. In contrast, calcium carbonate, while essential for maintaining bone mineral density, lacks the direct osteogenic stimulation required for rapid fracture repair.

The statistically significant reduction in healing time observed in the teriparatide group underscores its clinical value as an effective therapeutic option for enhancing post-surgical fracture recovery in osteoporotic patients. Given the high burden of osteoporotic fractures and their associated complications, the routine use of teriparatide in post-surgical care protocols may optimize patient outcomes, reduce immobilization time and lower the risk of nonunion or delayed union. Further large-scale, prospective, randomized controlled trials are recommended to validate these findings, assess long-term outcomes and explore the cost-effectiveness of teriparatide in diverse patient populations.

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