

CLINICAL AND RADIOLOGICAL OUTCOMES OF TERIPARATIDE VERSUS
STANDARD CARE IN FRACTURE HEALING: A COMPARATIVE STUDY ON BONE
UNION, BONE MINERAL DENSITY, AND SAFETYP. Ramya Priya^{1*}, M. Nikhitha Reddy¹, P. Dali Bhanu¹, C. Venkatesh¹, Dr. C. Venkatesh², Dr. N. M. Vageesh³,
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Yemmiganur - 518360, Kurnool District, Andhra Pradesh, India.DOI: <https://doi.org/10.5281/zenodo.23801855>**How to cite this Article:** P. Ramya Priya^{1*}, M. Nikhitha Reddy¹, P. Dali Bhanu¹, C. Venkatesh¹, Dr. C. Venkatesh², Dr. N. M. Vageesh³, Dr. N. Bala Krishna⁴. (2026). Clinical and Radiological Outcomes of Teriparatide Versus Standard Care In Fracture Healing: A Comparative Study on Bone Union, Bone Mineral Density, And Safety. European Journal of Pharmaceutical and Medical Research, 13(11), 307–314.

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ABSTRACT

Background: Bone fracture healing is a multifactorial process where conventional conservative treatment of bone fractures with calcium and vitamin D is more about bone mineralisation than enhancement of tissue regeneration. Teriparatide is an artificial parathyroid hormone that acts as an anabolic substance by stimulating the formation of bone through activation of osteoblasts. The current study aimed to compare the effects of teriparatide with those of conventional conservative treatment in patients suffering from bone fractures. **Methods:** A prospective comparative observational study was carried out for a period of 6 months on 90 subjects. Subjects were divided into two groups; Group A comprised subjects given teriparatide injection (20 mcg per day), and Group B subjects were given normal oral intake of calcium and vitamin D supplements. We monitored clinical and radiological progression at baseline, 4 weeks, 8 weeks, and 12 weeks. Quantification of outcomes was done through various parameters used in the evaluation of bone fracture healing, such as TARHS, TCMI, and BHPS, in addition to the evaluation of bone mineral density (BMD) using dual-energy X-ray absorptiometry. **Results:** Patients in the teriparatide group demonstrated statistically significant superior outcomes across all validated clinical healing indices compared to the standard care group ($p < 0.05$). Serial radiographic assessments revealed earlier bridging trabeculae, robust periosteal callus formation, and substantially accelerated structural fracture union in the teriparatide arm. Furthermore, longitudinal assessments indicated a marked increase in local and systemic bone mineral density compared to calcium and vitamin D supplementation alone. Both therapeutic regimens demonstrated favourable safety profiles, with minimal adverse events and high overall patient tolerance. **Conclusions:** Daily administration of teriparatide provides superior therapeutic efficacy over standard calcium and vitamin D supplementation by significantly shortening union time, promoting robust callus architecture, and elevating bone mineral density. Teriparatide represents an effective osteoanabolic intervention for fracture management, particularly in patients presenting with impaired regenerative capacity or an elevated risk of delayed union.

KEYWORDS: Teriparatide, Fracture healing, Bone mineral density, Bone union, Calcium, Vitamin D.

INTRODUCTION

The human skeleton provides critical mechanical support for the body, anchors muscles and soft connective tissues, shields thoracic and abdominal viscera, houses marrow spaces, and governs systemic mineral homeostasis through hematopoiesis and ion reservoir storage. Bone tissue represents a dynamic composite matrix comprising specialised cells, extracellular matrix (ECM), lipids, and water. The organic matrix is mainly made up of type I collagen, proteoglycans, osteocalcin, osteopontin, and glycoproteins, while the inorganic matrix includes hydroxyapatite, tricalcium phosphate, and calcium carbonate compounds. The cellular population includes osteoblasts that synthesise, deposit, and mineralise matrix; osteocytes trapped within lacunae that orchestrate mechanotransduction and tissue maintenance; multinucleated osteoclasts derived from the monocyte-macrophage lineage that drive controlled resorption; and osteogenic precursor cells that sustain cellular replenishment. Morphologically, bone presents as a cancellous trabecular meshwork in epiphyseal regions and dense cortical compact bone organised into functional osteon units. During skeletal repair, immature woven bone develops initially before undergoing structural maturation into organised lamellar bone, relying critically upon extensive periosteal, medullary, and metaphyseal vascular perfusion networks.

Fractures constitute disruptions in structural continuity resulting from traumatic impacts, underlying systemic diseases, or cumulative biomechanical loading. Traumatic breaks stem from high-energy kinetic forces such as motor vehicular accidents, direct impacts, or severe falls. Pathological fractures arise under trivial physiological loads due to osteolytic lesions, bone malignancies, localised infections, or underlying osteoporosis. Stress fractures develop progressively through unremitting repetitive cyclic stress surpassing intrinsic remodelling rates. Anatomical configurations range across transverse, oblique, spiral, highly comminuted, crushed vertebral compression, pediatric greenstick, ligamentous avulsion, and high-velocity projectile gunshot patterns.

Healing follows a continuous biological continuum beginning with immediate hematoma formation and inflammatory debris debridement by neutrophils and macrophages. This phase progresses into fibrocartilaginous soft callus bridging, subsequent vascularized hard bony callus conversion mediated by osteoblasts, and ultimate lamellar remodelling along mechanical stress vectors. Despite advancements in orthopaedic surgical fixation, delayed healing or non-union persists in significant subsets of patients, frequently precipitated by advanced age, compromised nutritional state, decreased bone mineral density, diabetes mellitus, tobacco consumption, and biomechanical instability.

These clinical challenges have prompted extensive exploration of osteoinductive therapies beyond standard conservative protocols. Conventional management consists of mechanical immobilisation, rigid internal fixation, physical therapy, and nutritional co-administration of calcium carbonate along with cholecalciferol (Vitamin D). Calcium is the basic element responsible for callus mineralisation, matrix calcification, and bone conservation. Vitamin D facilitates intestinal calcium and phosphate uptake, directly enhancing mineralisation pathways and preventing osteomalacic defects. However, while indispensable for preventing baseline nutritional deficiencies and supporting passive calcification, standard calcium and vitamin D therapy does not actively accelerate cellular osteogenesis. Additionally, excessive therapeutic administration carries known clinical risks of hypercalcemia, persistent constipation, gastrointestinal discomfort, and nephrolithiasis.

On the other hand, teriparatide is a recombinant form of human parathyroid hormone that acts as an extremely effective osteoanabolic drug. Whereas endogenous parathyroid hormone is continuously produced, resulting in the net catabolism of bones, teriparatide works by selectively activating parathyroid hormone receptors to promote osteoblastogenesis, enhance organic matrix production, and induce endochondral ossification. Beyond its primary established indication in systemic osteoporosis, teriparatide exhibits notable therapeutic promise as an adjunct for fragility fractures, non-unions, and high-risk surgical cases. Translational investigations demonstrate its capacity to enhance bone mineral density, improve callus biomechanical stiffness, accelerate cortical bridging, reduce patient pain profiles, and shorten recovery intervals to functional ambulation.

Evaluating treatment efficacy requires balancing subjective clinical metrics, including pain score attenuation and functional limb recovery indices, with rigorous radiographic indicators like cortical bridging, trabecular crossing, and callus volume. Although multiple clinical trials confirm faster clinical union and superior functional outcomes with teriparatide over standard calcium and vitamin D therapy alone, variable findings remain regarding absolute radiological union rates. This clinical variance stems from modest sample sizes, structural heterogeneity across fracture patterns, differing demographic profiles, and inconsistent dosing intervals. As a result, while calcium and vitamin D remain essential foundational nutrients for passive mineralisation, teriparatide offers a targeted anabolic approach to actively accelerate structural healing in patients facing compromised skeletal regeneration.

MATERIALS AND METHODS

Aim: To assess the clinical and radiographic efficacy of teriparatide therapy against calcium and vitamin D supplementation in fractures.

Objectives

- To compare the speed of healing and time to healing in the case of teriparatide versus standard treatment.
- To measure radiological healing by performing follow-up X-rays.
- To compare the effects on BMD, analgesia, and rehabilitation.
- To determine the safety and tolerability of teriparatide treatment versus standard treatment of calcium and vitamin D supplementation.

Need for the study

Teriparatide may enhance bone formation and accelerate fracture healing compared with standard calcium and vitamin D supplementation. However, its clinical effectiveness and safety in fracture healing require further evaluation. This study aims to compare both treatments in terms of bone union, BMD improvement, and safety.

Study Method

Study design: Prospective Comparative Observational Study

Study period: Carried out over a period of 6 months

Study Site: The experiment was performed at Ameelio Hospital, Kurnool, in the Orthopaedics Department.

Sample Subject: A total of 90 patients were selected from the Department of Orthopaedics.

Group A: 45 patients (Teriparatide 20 mcg/day, prefilled pen for 28 days administered subcutaneously)

Group B: 45 patients (Calcium 500mg to 1.2 g and Vitamin D 200 to 500 IU)

Statistical Analysis: Descriptive statistics, Student's t-test using MS Excel

Study Criteria

Inclusion Criteria

- ☐ Age between 20 and 80
- ☐ Patients underwent surgical fixation for (Periprosthetic, osteoporotic, distal radius)
- ☐ Patients prescribed teriparatide or Calcium and Vitamin D
- ☐ Patients willing to give consent
- ☐ Different types of fractures, especially long bones and Hip fractures

Exclusion Criteria

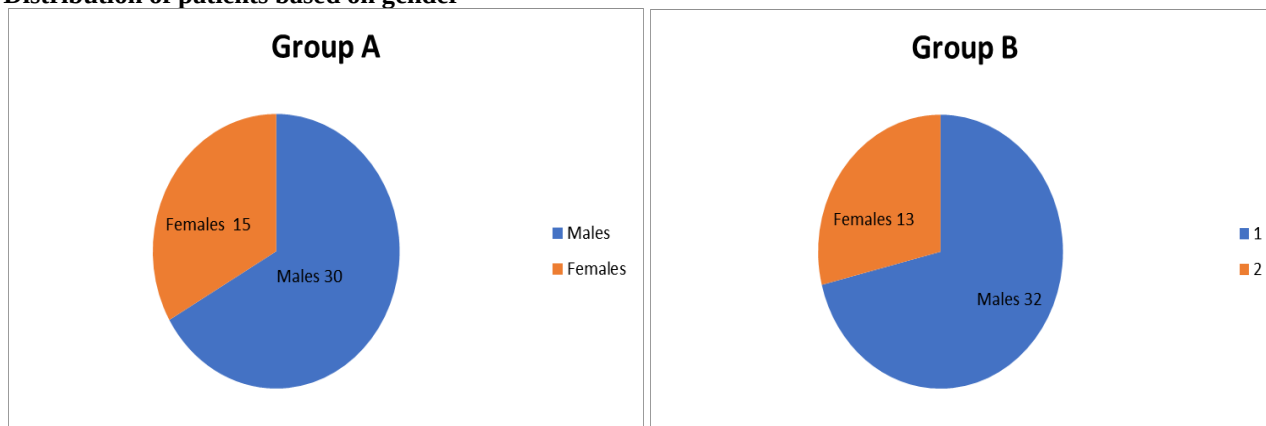
- ☐ Patients aged below 20 years, those with compound or pathological fractures, pregnant or lactating women, patients receiving corticosteroids, and those with chronic renal or hepatic disease, hyperparathyroidism, or hypercalcemia will be excluded from the study.

RESULT

Gender Wise Distribution

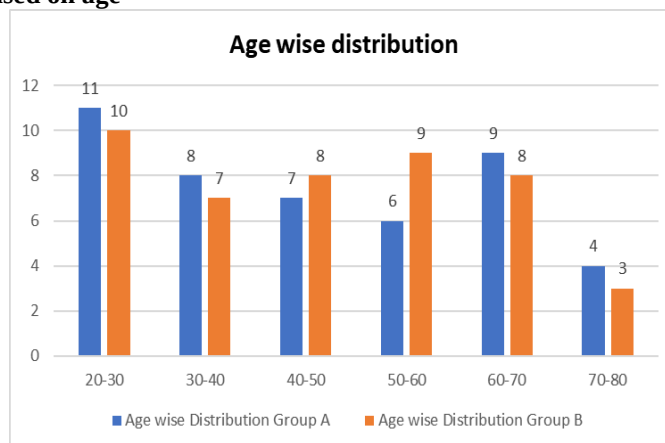
Gender	Group A	Group B	Total
Male	30	32	62
Female	15	13	28

Distribution of patients based on gender

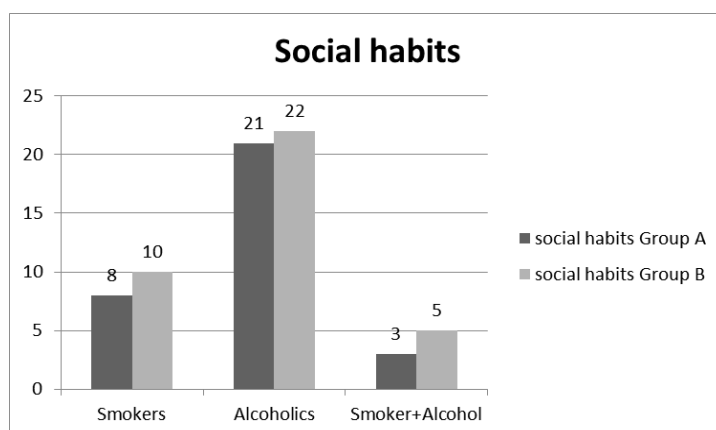


Age-wise Distribution

Age group	Group A	Group B	Total
20–30	11	10	21
30–40	8	7	15
40–50	7	8	15
50–60	6	9	15
60–70	9	8	17
70–80	4	3	7

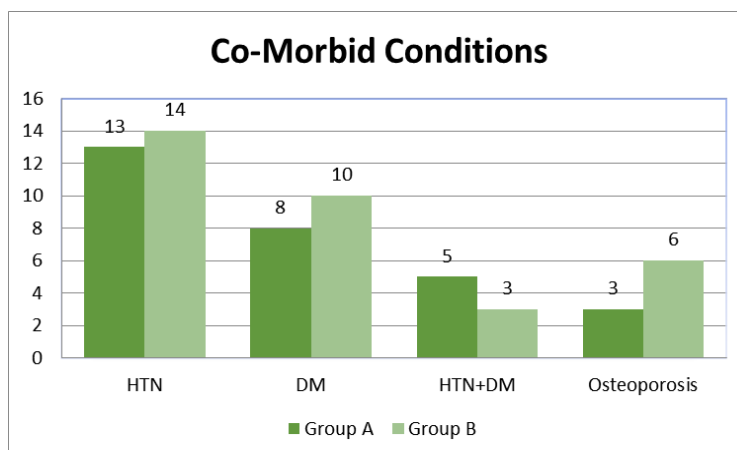
Distribution of patients based on age**Distribution of subjects based on social habits**

Social habits	Group A	Group B	Total
Smokers	8	10	18
Alcoholics	21	22	43
Smoker + Alcohol	3	5	8



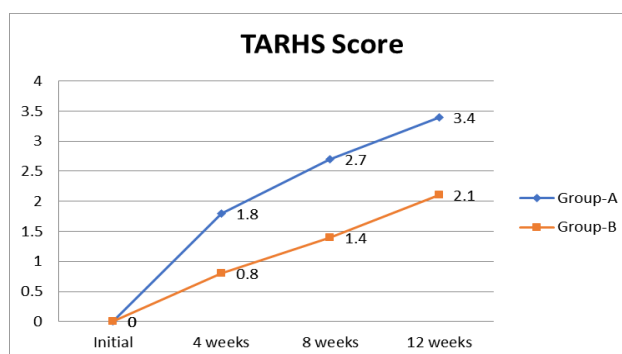
Co-Morbid Conditions			
Co-Morbidities	Group A	Group B	Total
HTN	13	14	27
DM	8	10	18
HTN+DM	5	3	8
Osteoporosis	3	6	9

Distribution of subjects based on comorbid conditions



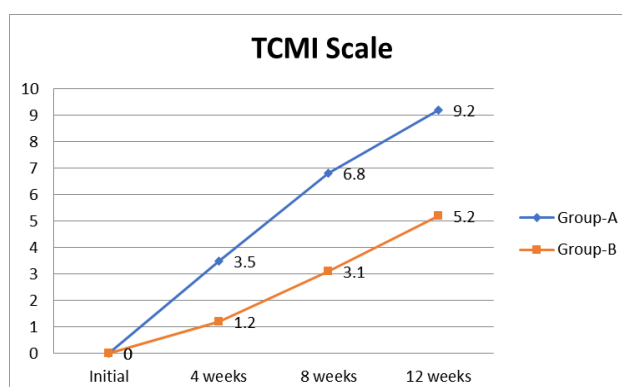
Distribution of Subjects Based on TARHS Scale

TARHS scale	Group-A	Group-B	P*Value
Initial	0	0	N/A
4 weeks	1.8±0.4	0.8±0.6	<0.05
8 weeks	2.7±0.5	1.4±0.5	<0.05
12 weeks	3.4±0.5	2.1±0.3	<0.05



Distribution of Subjects Based on TCMI Grade

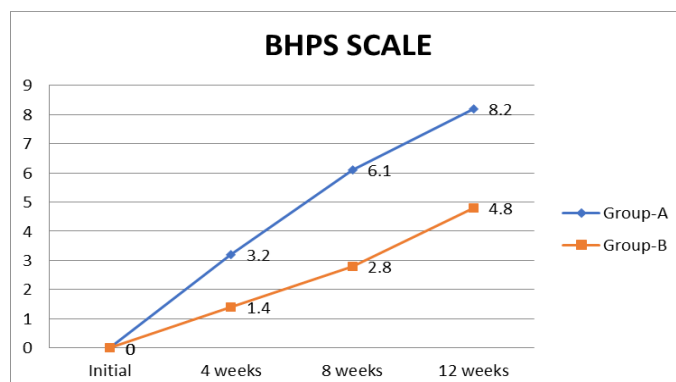
TCMI scale	Group-A	Group-B	P*Value
Initial	0	0	N/A
4 weeks	3.5±0.8	1.2±0.6	<0.05
8 weeks	6.8±1.2	3.1±0.8	<0.05
12 weeks	9.2±1.1	5.2±1.4	<0.05



Distribution of Subjects Based on BHPS Grade

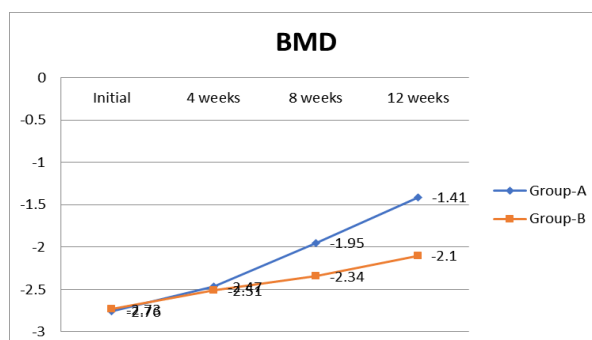
BHPS Scale	Group-A	Group-B	P*Value
Initial	0	0	N/A
4 weeks	3.2±0.6	1.4±0.5	<0.05
8 weeks	6.1±0.9	2.8±0.7	<0.05

12 weeks	8.2±0.8	4.8±1.0	<0.05
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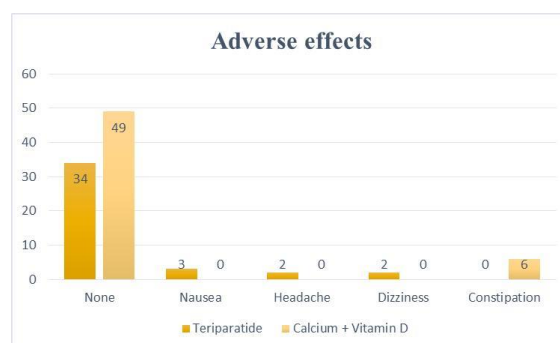
Distribution of subjects based on Bone Mineral Density

BMD	Group-A	Group-B	P*Value
Initial	-2.76	-2.73	0.22
4 weeks	-2.47	-2.51	0.01
8 weeks	-1.95	-2.34	<0.05
12 weeks	-1.41	-2.1	<0.05



Adverse effects

Adverse Effect	Teriparatide	Calcium + Vitamin D
None	34	49
Nausea	3	0
Headache	2	0
Dizziness	2	0
Constipation	0	6



X-ray (Teriparatide)

Before Teriparatide

After Teriparatide



The 3-month follow-up X-ray shows progressive healing of the femoral fracture following teriparatide treatment, with increased callus volume and density, bridging of the X-ray (calcium + vitamin D)

Before Calcium + Vitamin D



The X-rays show a distal radius fracture treated with a metal plate and screws. Increased callus volume and density, bridging of the fracture gap by new bone, and reduced visibility of the fracture line indicate progressive bone healing and fracture union following calcium and vitamin D supplementation.

DISCUSSION

A prospective study was conducted to compare teriparatide with calcium and vitamin D in 90 fracture patients. Male and older patients were more common, with hypertension and diabetes as frequent comorbidities. The teriparatide group showed better clinical and radiological healing scores (TARHS, TCMI, and BHPS), greater improvement in bone mineral density (1.4 vs. 0.6), and no cases of poor healing. Both treatments were generally safe, with mild adverse effects in the teriparatide group and minimal effects in the calcium and vitamin D group. Overall, teriparatide demonstrated better fracture healing and bone quality improvement than standard supplementation.

CONCLUSION



fracture gap by new bone, and reduced visibility of the fracture line, indicating improved bone formation and progressive fracture union.

After 3 months of Calcium + Vitamin D



Based on this current study, it is clear that teriparatide treatment for fracture healing is much more effective compared to the combination of calcium and vitamin D. Teriparatide demonstrated superior outcomes in terms of faster and better bone union, improved radiological healing, and greater enhancement of bone mineral density. Though calcium and vitamin D have a fundamental supportive role in bone formation, they have limited value in treating fractures as a monotherapy due to their limited effectiveness.

Though teriparatide is relatively expensive, it can be regarded as a good choice from a therapeutic standpoint, especially in patients who are prone to delayed healing, osteoporosis, or complications. Calcium and vitamin D are equally valid choices in patients who cannot afford teriparatide. Overall, teriparatide offers a promising and effective approach for improving fracture healing outcomes with an acceptable safety profile.

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ETHICAL APPROVAL: The study was conducted at Ameelio Hospital, Kurnool, Andhra Pradesh, India. The details of approval by the Institutional Human Ethics Committee, including the approval reference number SJCPs/IEC/V PD/2025-2026/050A and 01/11/25 to 30/04/26 (6 Months), are being verified against the original documentation.

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