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Review of the Literature on the Impact of Teriparatide Use on Bone Healing

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Introduction: Fractures, especially hip fractures, represent a growing health issue in aging societies. Recovery of mobility after such an injury can be prolonged and not always complete, affecting patients' quality of life. Modern medicine is exploring methods to support healing, including parathyroid hormone (PTH) therapy, which stimulates bone tissue formation, opening new perspectives in fracture treatment.

Aim of the study: The objective of this study is to review current scientific reports and summarize the existing knowledge on the impact of teriparatide supplementation on bone healing after fractures. The analysis evaluates whether teriparatide supplementation accelerates fracture healing, improves bone union quality, and reduces complications associated with impaired healing. The study is based on a review of scientific literature and recent clinical trial findings, providing a comprehensive understanding of the current knowledge base and identifying areas for future research.

Materials and Methods: A review of randomized clinical trials (RCTs) published between 2016 and 2024 regarding **the impact of teriparatide use on bone healing**. Four studies meeting specific selection criteria were identified.
Results: The majority of analyzed studies demonstrated that the use of teriparatide improves bone mineral density. This effect was particularly pronounced among patients with prolonged teriparatide administration. In certain studies (e.g., those by Lee SY and Huang), a faster bone healing process and improved radiographic outcomes were observed in patients receiving teriparatide. Patients undergoing teriparatide supplementation reported reduced pain perception and improved mobility compared to control groups, suggesting a positive impact of the therapy on patients' quality of life during the recovery period.
Conclusions: The use of teriparatide shows potential as an effective therapy to enhance recovery after bone fractures.

Keywords: teriparatide, bone healing.

Introduction

Bone fractures have become an increasingly significant public health concern in aging societies worldwide. It is estimated that by 2025, approximately four million hip fractures will occur globally, with a substantial proportion involving low-energy fractures in elderly individuals. [1] Recovery after a bone fracture, particularly hip fractures, is often a prolonged process that does not always result in a full return to pre-injury functional levels. Many individuals face long-term reductions in daily activities, significantly impacting their quality of life. [2]

Given the profound health and quality-of-life consequences for affected individuals, finding new strategies to enhance bone healing has become a critical focus of modern medicine. While numerous surgical techniques effectively stabilize fractures, researchers have increasingly explored pharmacological approaches to support surgical interventions, aiming to accelerate healing and improve bone regeneration. Various agents, including bisphosphonates, bone morphogenetic proteins, and parathyroid hormone (PTH), have been investigated for this purpose.

PTH plays a central role in bone metabolism by stimulating bone formation. In recent years, extensive research has explored its potential in promoting fracture healing. Recombinant human PTH is already approved for treating osteoporosis in postmenopausal women, where systemic administration aims to increase bone formation. [3]

Research has demonstrated that the effects of PTH supplementation depend on the administration method and dosage. Continuous PTH administration stimulates bone resorption, potentially hindering fracture healing. Conversely, intermittent dosing enhances bone formation by increasing osteoblast number and activity. [4]

These findings open new perspectives in fracture treatment, offering the potential to accelerate bone healing and improve clinical outcomes. Future research may refine optimal PTH administration strategies, ultimately enhancing patient recovery and reducing fracture-related health burdens in aging populations.

Aim of the study

The objective of this study is to review current scientific reports and summarize the existing knowledge on the impact of teriparatide supplementation on bone healing after fractures. The analysis evaluates whether teriparatide supplementation accelerates fracture healing, improves bone union quality, and reduces complications associated with impaired healing. The study is based on a review of scientific literature and recent clinical trial findings, providing a comprehensive understanding of the current knowledge base and identifying areas for future research.

Methods

A literature review was conducted in December 2024 using the PubMed database. Relevant articles were identified using keywords such as "parathyroid hormone," "teriparatide," and "bone fracture." The search was limited to publications from 2016 to 2024. Clinical trials involving adult populations were included.

After initial screening, 35 randomized controlled trials (RCTs) were identified. Inclusion criteria were as follows:

1. RCTs
2. Interventions involving teriparatide supplementation
3. Studies involving patients with bone fractures
4. Articles published in peer-reviewed journals

Exclusion criteria included studies other than RCTs. The findings were synthesized to provide an up-to-date overview of the role of teriparatide in promoting bone healing after fractures.

Results

The final analysis included four studies published between 2016 and 2024. The characteristics of the reviewed studies, presented chronologically, are summarized in Table 1.

First author, month, year of publication:	**Number of participants, age:**	**Study duration:**	**Inclusion criteria:**	**Intervention group:**	**Control group:**
Lee SY, 08.2023	221; 65 years or older	3 months	Patients aged 65+ after surgical treatment for hip fractures	Weekly teriparatide injections (56.5 µg/week)	Saline solution
Bhandari M, 03.2016	161; 50 years or older	6 months	Postmenopausal men and women aged 50+ with unilateral		Placebo

			femoral neck fractures		
Johansson T, 01.2016	40; average age 67 years (range 54-82 years)	4 weeks	Postmenopausal women with proximal humerus fractures	Daily subcutaneous injections of 20 µg teriparatide	No placebo injections
Huang TW, May 2016	82 participants (age range: 65–89 years)	12 months	Patients with intertrochanteric fractures (AO/OTA 31-A1) treated with dynamic hip screw (DHS) fixation	Teriparatide supplementation along with calcium (600 mg) and vitamin D3 (800 IU) daily	Calcium (600 mg) and vitamin D3 (800 IU) supplementation daily

Table 1. Characteristics of the scientific studies included in the literature review.

Lee SY's team evaluated the efficacy of weekly subcutaneous teriparatide injections in postmenopausal women with hip fractures, defined as femoral neck and intertrochanteric fractures. [5] The intervention group received weekly teriparatide injections for three months, while the control group received saline. All participants underwent surgical osteosynthesis and received calcium and vitamin D supplementation. Radiographic assessments were conducted postoperatively, at three months, six months, and one year.

The study found no statistically significant differences in bone metabolism markers between the groups. However, osteocalcin levels tended to increase in the teriparatide group. Additionally, femoral neck and lumbar spine bone mineral density (BMD) showed an upward trend in the intervention group, contrasting with a decline in the control group. After prolonged observation, lumbar spine BMD in the intervention group increased by over 7%. The Radiographic Union Score for Hip (RUSH) indicated significantly higher scores at three and six months in the teriparatide group, suggesting accelerated bone healing.

Bhandari's team [6] assessed teriparatide's effect on femoral neck fracture healing in patients aged 50 and older with unilateral low-energy femoral neck fractures treated with internal fixation. The intervention group received a single subcutaneous teriparatide injection, while the control group received a placebo. Both groups received calcium and vitamin D supplementation. The six-month observation revealed that teriparatide did not reduce the need for revision surgery or improve radiographic healing after one year. Researchers attributed the lack of differences to the study's limited sample size.

Johansson's team [7] investigated teriparatide's impact on humeral fracture healing in non-surgically treated patients. The intervention group received daily subcutaneous teriparatide injections for four weeks, while the control group received no placebo injections.

Pain assessments at three months showed no statistically significant differences between groups. Radiographic evaluations and functional outcomes also revealed no significant improvements. Researchers speculated that the intervention duration might have been too short and the teriparatide dose potentially suboptimal. The absence of a placebo group in the control arm might have further biased results.

Huang's team [8] evaluated teriparatide's effect on intertrochanteric fracture healing. All patients underwent DHS fixation. The control group received calcium and vitamin D supplements, while the intervention group additionally received teriparatide. The study demonstrated that teriparatide significantly improved BMD and expedited fracture healing. Intervention group patients reported less pain and showed better mobility at three and six months postoperatively.

Discussion

The majority of analyzed studies demonstrated that the use of teriparatide improves bone mineral density. This effect was particularly pronounced among patients with prolonged teriparatide administration. In certain studies (e.g., those by Lee SY and Huang), a faster bone healing process and improved radiographic outcomes were observed in patients receiving teriparatide. Patients undergoing teriparatide supplementation reported reduced pain perception and improved mobility compared to control groups, suggesting a positive impact of the therapy on patients' quality of life during the recovery period.

The variability in the outcomes of these studies may be attributed to differences in study design. Factors such as sample size, intervention duration, teriparatide dosage, and the absence of placebo in control groups could have influenced the results. The findings suggest that teriparatide may be particularly beneficial in treating fractures with a high risk of complications, such as intertrochanteric fractures or hip fractures in postmenopausal patients. However, the lack of clear benefits for other types of fractures, such as humeral fractures, underscores the need for further research on the drug's mechanisms of action and optimization of treatment protocols. Specifically, determining appropriate doses, intervention duration, and identifying patient groups most likely to benefit from the therapy remain critical.

The reviewed scientific studies demonstrated that teriparatide positively affects bone mineral density (BMD), which may enhance bone tissue regeneration. These findings align with previous reports emphasizing the drug's potential benefits in increasing BMD. [9] Similar results were reported by Kleerekoper's team. [10] Their study confirmed increased BMD in the spine and femoral neck after teriparatide treatment, although no significant changes in bone microarchitecture were observed. Estimated vertebral and femoral bone strength also improved. Research indicates that teriparatide administration affects markers of anabolic bone responses. Bashutski's team demonstrated a significant increase in bone-specific alkaline phosphatase (BSAP) levels after six weeks in patients receiving teriparatide compared to a decline in the placebo group, suggesting a positive therapeutic effect on bone healing.

Bone-specific alkaline phosphatase is an enzymatic marker associated with osteoblast activity; the cells responsible for forming new bone tissue. An increase in BSAP levels indicates enhanced osteoblast activity, which is essential for fracture healing and bone regeneration. The statistically significant difference between the intervention and placebo groups in the referenced study suggests that teriparatide treatment may accelerate bone healing by stimulating new bone formation. [11]

A literature review on the impact of teriparatide on fracture healing revealed diverse outcomes depending on fracture type, intervention protocols, and study conditions. These results contribute valuable insights into teriparatide's therapeutic potential while highlighting the necessity for further research to clarify unresolved ambiguities.

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The author does not report any disclosures.

Author contribution

The author is responsible for the conception, literature review, data analysis, and writing of the manuscript. All aspects of the study were conducted independently by the author.

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Conflicts of Interest

The author declares no conflicts of interest.

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