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REVIEW

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Teriparatide as treatment of the Medication Related Osteonecrosis of the Jaws (MRONJ): a Scoping Review

Jessika Dethlefs Canto [1,2] | **Montserrat Hurtado Almonacid** [3] | **Javiera Pérez Escobari** [3] | **Alexis Bustos Ponce** [1,4] | **Javier Villavicencio Duarte** [1] | **Solange Baeza Vallejos** [1]

[1]Department of Oral and Maxillofacial Surgery, University of Valparaíso – Valparaíso, Chile

[2]Department of Oral Surgery, School of Dentistry, Fluminense Federal University, Niteroi, Brasil

[3]General Dentist, University of Valparaíso – Valparaíso, Chile

[4]Hospital de Urgencia Asistencia Pública – Santiago, Chile

Correspondencia
Dra. Jessika Dethlefs Canto.
Altamirano Subida Carvallo 211, Valparaíso, Chile
+56 9 93231103
Email: jessika.dethlefs@uv.cl

Introduction: Medication-related osteonecrosis of the jaw (MRONJ) is a serious complication affecting patients undergoing therapy with bisphosphonates and other antiresorptive agents. Teriparatide, a parathyroid hormone analog, has emerged as a possible therapeutic option to promote bone regeneration in these cases. This study aims to evaluate the efficacy of teriparatide in the treatment of MRONJ. **Material and methods:** An exploratory review was performed following Prisma ScR protocols using the following bibliographic databases Scopus, Pubmed, WOS, ScienceDirect to identify studies between the years 2020 and 2024 that have used teriparatide as a treatment to MRONJ. **Results:** From a total of 3100 articles, 8 were included in this review. The following were considered as relevant criteria: initial MRONJ status, dose and time of drug administration and possible adverse effects developed with this therapy. The studies reviewed reported a significant improvement in bone regeneration and a reduction in MRONJ symptoms in patients treated with teriparatide, highlighting the decrease in bone exposure and showing a favorable safety profile. **Discussion:** The findings suggest that teriparatide may be a viable and effective therapeutic option for the treatment of drug-associated osteonecrosis of the jaws. However, the need for further research, particularly long-term clinical trials, to confirm these results and optimize treatment protocols is highlighted.

PALABRAS CLAVE

Teriparatide, Bisphosphonate-Associated osteonecrosis of the jaw, Treatment outcome, Adverse effects,

1 | INTRODUCTION

Medication-associated osteonecrosis of the jaws (MRONJ) is a pathology characterized by the presence of exposed, necrotic bone in the mandible or maxilla, which can be probed through an intraoral or extraoral fistula that does not heal within eight weeks in patients who have received treatment with antiresorptive or antiangiogenic drugs, in the absence of radiotherapy in the craniofacial region[1]. The main drugs implicated in the etiology of MRONJ are bisphosphonates, such as alendronate and zoledronate, and RANK ligand inhibitors (denosumab), used mainly in the treatment of metabolic bone diseases such as osteoporosis and in the management of bone metastases. In the bones that make up the facial mass, the maxillary bone and more probably the mandible (65%-95.24%) may be involved, due to their greater bone density and lower irrigation, and may develop simultaneously in both bones[2]. The risk factors for its appearance can be local or systemic. Local factors include active periodontal disease, poorly fitted removable or fixed prostheses and exodontia. Systemic factors include age, smoking, vitamin D deficiency, diabetes mellitus and a history of MRONJ. This risk increases considerably with prolonged ingestion of the aforementioned drugs[3, 4]. MRONJ is classified into different stages, each with specific implications for treatment. In stage I (asymptomatic exposed bone) treatment focuses on prevention of disease progression and symptom relief. Treatment options include the use of antiseptic mouth rinses (such as chlorhexidine), improved oral hygiene to remove biofilm from the necrotic area, and regular clinical follow-up. Discontinuation of antiresorptive medications may be considered, although this depends on the risk-benefit to the patient. Surgery is not indicated in the absence of disease progression[5]. In stage II (exposed bone with pain and signs of infection) treatment includes systemic antibiotics, antiseptic mouth rinses, and in some cases, surgical debridement to remove necrotic bone. In stage III (exposed bone with more severe complications such as necrotic extension beyond the alveolar bone, pathologic fracture, extraoral fistulas, oro-antral or oro-nasal communication, osteolysis extending to the base of the mandible or sinus floor) management is more aggressive and includes segmental surgery to remove extensive necrotic bone[3]. Teriparatide (PTH 1-34), a recombinant human protein composed of the first 34 amino acid fragments of parathyroid hormone, has become popular in the treatment of osteoporosis due to the increased bone formation resulting from its anabolic effect[6]. Teriparatide has recently been integrated as a treatment option for MRONJ because it reverses the antiresorptive effect of bisphosphonates by promoting osteoblast activity and improving osteoclast metabolic function, promoting healing in patients with MRONJ and increasing bone density, usually used in patients who do not respond to conventional treatment[7]. Allen et al. reported significant improvements in bone healing and symptom reduction in patients treated with teriparatide after failure of conventional therapies[8]. Based on the above, this study aims to evaluate the efficacy of teriparatide in the treatment of MRONJ, based on an exploratory systematic review of the current literature.

2 | MATERIAL AND METHODS

The protocol of the present study was based on the framework of Peters et al. according to The Joana Briggs Institute and is available on the Open Science Framework platform[9]. The reporting was based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR). The PCC question was formulated as follows: Is the use of teriparatide effective and safe in patients with drug-associated osteonecrosis of the jaws? (Table I)

People	MRONJ patients
Concept	Teriparatide Treatment
Context	Not applicable

TABLE 1 PCC question

The search strategy was independently carried out in English and Spanish by researchers (M.H.A.; J.P.E.) in parallel across Scopus, PUBMED, Web Of Science y ScienceDirect with a maximum restriction of 10 years. Search terms in titles and abstracts included MESH

terms “Teriparatide”, “Bisphosphonate-Associated Osteonecrosis of the Jaw”, “Treatment outcome” y “Adverse Effects combined using The Booleans operators ¨AND¨ and ¨OR¨. (Table II)

Search terms	Results
Scopus	
#1 TITLE-ABS-KEY (Teriparatide AND Bisphosphonate-Associated Osteonecrosis of the Jaw AND treatment outcome)	Results: 19
#2 TITLE-ABS-KEY (Teriparatide AND Bisphosphonate-Associated Osteonecrosis of the Jaw)	Results: 64
#3 TITLE-ABS-KEY (Teriparatide AND Adverse effects)	Results: 188
#4 TITLE-ABS-KEY (Teriparatide AND Bisphosphonate-Associated Osteonecrosis of the Jaw AND Adverse effects)	Results: 199
#5 TITLE-ABS-KEY (Teriparatide AND Treatment outcome AND Bisphosphonate-Associated Osteonecrosis of the Jaw AND Adverse effects)	Results:155
Pubmed	
#1 (Teriparatide) [MeSH Terms] AND (Bisphosphonate-Associated Osteonecrosis of the Jaw) [MeSH Terms] AND (Treatment outcome) [MeSH Terms]	Results: 13
#2 (Teriparatide) [MeSH Terms] AND (Bisphosphonate-Associated Osteonecrosis of the Jaw) [MeSH Terms]	Results: 53
#3 (Teriparatide) [MeSH Terms] AND (Adverse effects) [MeSH Terms]	Results: 419
#4 (Teriparatide) [MeSH Terms] AND (Bisphosphonate-Associated Osteonecrosis of the Jaw) [MeSH Terms] AND (Adverse effects) [MeSH Terms]	Results: 35
#5 (Teriparatide) [MeSH Terms] AND (Treatment outcome) [MeSH Terms] AND (Bisphosphonate-Associated Osteonecrosis of the Jaw) [MeSH Terms] AND (Adverse effects) [MeSH Terms]	Results: 8
WOS	
#1 Teriparatide AND Bisphosphonate-Associated Osteonecrosis of the Jaw AND Treatment outcome (All Fields)	Results:3
#2 Teriparatide AND Bisphosphonate-Associated Osteonecrosis of the Jaw (All Fields)	Results:17
#3 Teriparatide AND Adverse effects (All Fields)	Results:95
#4 Teriparatide AND Bisphosphonate-Associated Osteonecrosis of the Jaw AND Adverse effects (All Fields)	Results: 0
#5 Teriparatide AND Treatment outcome AND Bisphosphonate-Associated Osteonecrosis of the Jaw AND Adverse effects (All Fields)	Results: 0
ScienceDirect	
#1 Teriparatide AND Bisphosphonate-Associated Osteonecrosis of the Jaw AND Treatment outcome	Results: 234
#2 Teriparatide AND Bisphosphonate-Associated Osteonecrosis of the Jaw	Results: 356
#3 Teriparatide AND Adverse effects	Results: 790
#4 Teriparatide AND Bisphosphonate-Associated Osteonecrosis of the Jaw AND Adverse effects	Results: 268
#5 Teriparatide AND Treatment outcome AND Bisphosphonate-Associated Osteonecrosis of the Jaw AND Adverse effects	Results: 184
Total	**3100**

TABLE 2 Search strategy with keywords used in PubMed, Scopus WOS y ScienceDirect.

Inclusion criteria

- Studies conducted in patients diagnosed with MRONJ and treated with teriparatide.
- Studies describing the clinical outcomes and/or adverse effects derived from the administration of teriparatide for the treatment of MRONJ.

Exclusion criteria

- Case reports.
- Book chapters.
- Letters to the editor.

The search yielded 3100 results, which were included in the Rayyan virtual tool to eliminate duplicate studies. Subsequently, a review of titles and abstracts was carried out, selecting 14 studies. After a complete reading of the selected articles, 6 studies were eliminated because they were included in systematic reviews, leaving 8 articles for complete reading. The analyses described above were carried out by two reviewers individually and independently. In case of disagreement, the inclusion and exclusion were analyzed together according to the previously established criteria, in addition to the relevance and the research question and objectives of the study. .

3 | RESULTS

From the databases a total of 3.100 publications were identified (100%). After removing 1,238 duplicate studies (40%) 1,862 studies remained for the next step of review (60%). Of these studies, those that did not meet the inclusion criteria were eliminated after reading the title and abstract. Among the excluded studies were letters to the editor, case reports, in vitro studies, studies in animal models and studies that did not directly address the research question. This reduced the number to 14 studies selected for full reading.

After reading the entirety, 6 more studies did not meet quality or relevance criteria, specifically studies that had already been included in previous systemic reviews. Finally, 8 studies were selected as described in figure 1 (Fig. 1).

3.1 | Characteristics of the Studies

In relation to the patients, 82.3% were female. Regarding the stage of drug-associated osteonecrosis of the jaws, 10.7% of the patients were diagnosed with stage 1, 63.8% with stage 2, and 25.5% with stage 3 (Table III). All patients were treated with teriparatide, with the time of consumption varying in a range from 8 weeks to approximately 112 weeks (26 months), with the average time being 31.4 weeks (7.2 months). Only 4 studies reported follow-up time, varying from 1 week to 104 weeks (24 months). Studies that include teriparatide for the resolution of MRONJ show clinical results such as reduction of pain, absence of purulent secretion and infection, fistula healing (intraoral or extraoral) and reduction of the area of necrotic bone exposure. Thirty-five percent of the patients presented clinical improvement in the picture of drug-induced osteonecrosis and 50% of the patients presented total resolution of the picture The use of this new therapy points to adverse effects described in clinical trials, which have a low incidence (17%) (Table III). Of 166 patients administered teriparatide in daily doses of 20 ug or weekly doses of 56.5 ug, 60.8% of the patients presented a complete resolution of the MRONJ picture, with absence of symptoms, bone and mucosal healing, absence of exposed bone, fistula healing, fracture resolution, among others. 20.5% of the patients presented a partial resolution of the case, mainly referring absence of symptomatology, but persistence of lesions and/or decrease in severity in 1 or 2 stages. In 18.7% of the patients there was no resolution of the case or improvement in the patient's condition.

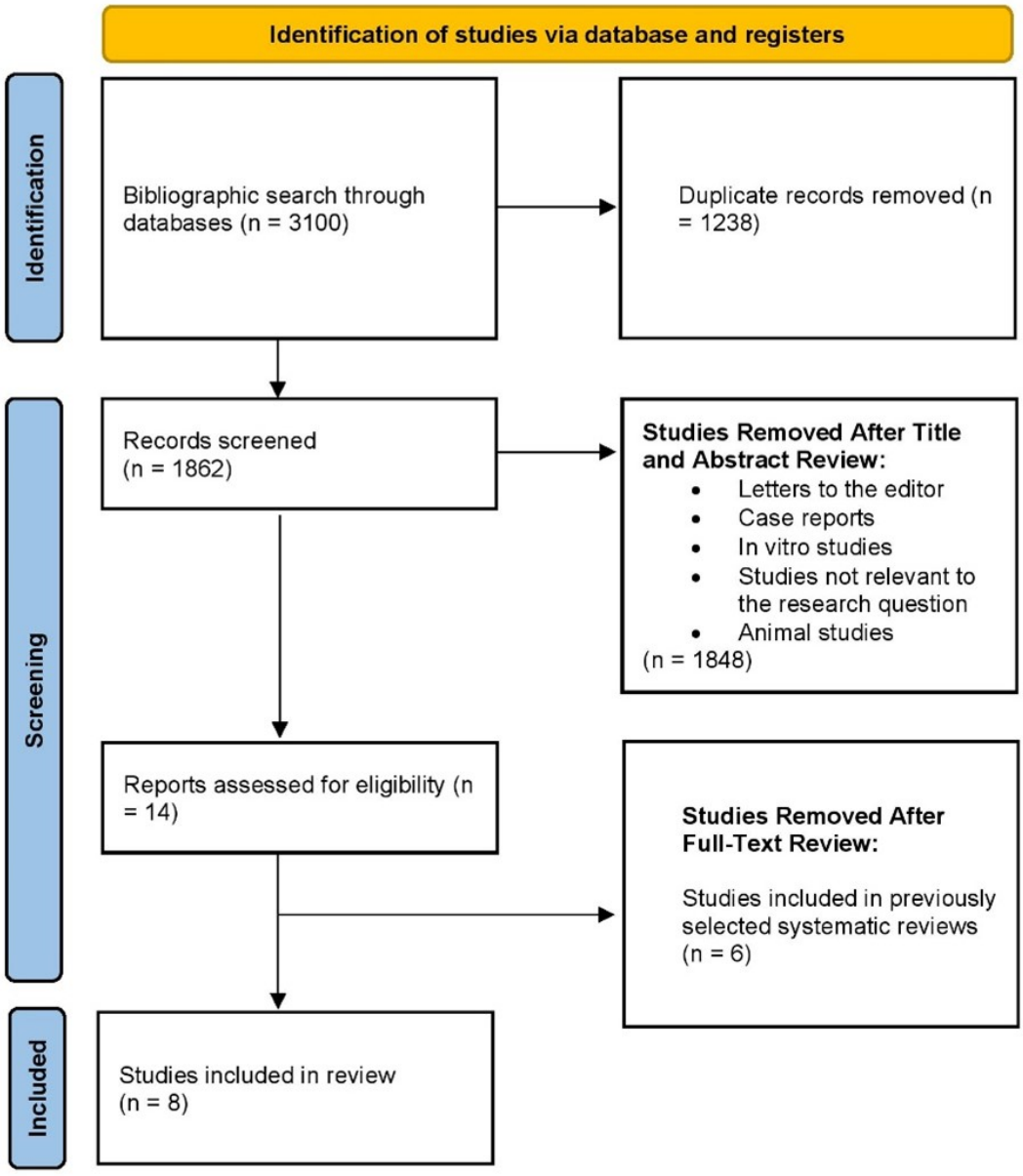

FIGURE 1 PRISMA Flowchart

Author	Type of Research	Mechanism of Action	Clinical Outcomes	Estadio MRONJ	Dosage	Consumption Time	Tracking Time	Internal Factors	External Factors	Adverse Effects
Sim le-Wen et al. 2020		No describe	Teriparatide was significantly associated with a better degree of resolution of MRONJ lesions. 80% of the participants had a significant reduction in the size of the bone lesions due to increased bone volume	Stage 1: 6 participants Stage 2: 7 participants Stage 3: 2 participants	20 ug subcutaneous /day	8 weeks	52 weeks	Female: 7 patients Males: 8 patients Reason for indication of oral bisphosphonates: 13 patients had a previous condition of malignancy. 10 patients had myeloma 1 patient had breast cancer, 2 patients had prostate cancer 2 patients with osteoporosis. Prevalent periodontitis in 8 patients 2 patients with diabetes mellitus	MRONJ Trigger Event: Exodoncia: 7 patients Pre-MRONJ treatment: Surgical intervention: 5 patients Antibiotic therapy: 8 patients Smoking: 4 patients Former smokers: 7 patients	86.7% of the participants had uncomplicated adverse effects. These are: nausea, vomiting, abdominal discomfort, constipation, pain at the injection site, myalgia, arthralgia, jaw pain. There were no new cases of malignancy nor were existing ones aggravated.
Yoshiga et al. 2013	Comparative Case Study	No describe	Daily Dose vs Weekly Dose Daily dose: 3 months later symptoms resolved, osteonecrosis resolved, and affected sites were coated with normal mucosa. CT showed partial recovery from the jaw fracture. S-NTX levels increased slightly after 2 months of starting teriparatide therapy, while P1NP levels increased significantly after 2 months of treatment. Weekly dose: After 3 months with weekly Teriparatide injections (56.5 µg), there was coating of necrotic areas and exposure of bone with normal mucosa. CT showed that stage 3 MRONJ-associated maxillary sinusitis resolved. S-NTX levels were found to be slightly elevated, and P1NP levels decreased after initiation of teriparatide therapy Participants: 2 Complete Resolution: 2	Stage 3: 2 patients	20 ug subcutaneous/day 56.5 ug subcutaneous / weekly	3 months	16 weeks	Female: 2 patients	Not described	Not described
Kim KM et al 2014	Longitudinal retrospective study	Teriparatide stimulates bone formation by osteoblasts and subsequent bone resorption by osteoclasts	All participants treated with teriparatide demonstrated improvements. 62.5% decreased 1 stage of MRONJ (moderate improvement) 37.5% decreased 2 stages with full resolution (advanced enhancement) The serum level of vitamin D was measured, inferring that those participants with optimal levels of vitamin D had better effects on teriparatide therapy. Participants: 15 Complete Resolution: 6 Partial Resolution:	Stage 2: 14 participants Stage 3: 1 participant	20 ug per day	6 months	Not described	Female: 14 participants Male: 1 participant	Treatment is complemented with the administration of calcium and vitamin D in all patients. MRONJ's triggering events were: Implants: 5 participants Exodontia: 7 participants Spontaneous development: 3 patients	Not described

Y. Ohbayashi et al. 2013	Clinical trial (pilot study)	Teriparatide has an anabolic effect on bone	Partial or complete remission was recorded in 5 of 6 patients in the daily dose group and in 3 of 6 patients in the weekly dose group. All patients in the study had a significant improvement in MRONJ stage (there was no significant difference when comparing clinical changes in stage between the two groups) with an average of 1 stage of improvement.	Stage 3: 4 patients Stage 2: 8 patients	6 patients daily dose 20 ug - 6 patients weekly dose 56.5 ug.	6 months	Not described	Female: 12 patients Rheumatoid arthritis: 5 patients	Not described	Not described
Morishita et al 2020	Multicenter retrospective study: 29 patients from 01/2012 to 12/2016	Teriparatide: being an anabolic compound, it has a stimulating effect on osteoblasts and later osteoclasts, increasing the formation of bone tissue through a positive regulation of bone metabolism. It has a therapeutic role in bone regeneration in bone fractures or bone defects. "	Pain, pus secretion, exposure of necrotic bone, and desensitization were studied. Successful treatment in 22 of the 28 participants. Complete resolution: 19 patients (average time 14 months) Partial Resolution: 3 patients No resolution: 6 patients MRONJ stage estable_ 6 patients (mean time 15 months) MRONJ exacerbation: 1 patient (with 2 months of treatment) Participants with bisphosphonate therapy (orally): Successful treatment in 20 of 24 participants. Participants on bisphosphonate therapy (intravenously): 60% of participants did not respond to treatment with teriparatide. Better outcomes were seen in participants with oral RA treatment than those with intravenous RA. The mechanism of treatment success is not described. The effectiveness of treatment is affected by the amount of nitrogen present in bisphosphonates. The higher the percentage of nitrogen, the lower the efficacy of the treatment (according to literature)	Categorized according to "Position Paper 2017 of the Japanese Allied Committee on Osteonecrosis of the Jaw" Stadium 1: 1 participant Stage 2: 21 participants Stage 3: 7 participants	Daily dose of 20 ug (subcutaneous)	From 0.3 to 26 months. Average time of 14 months. 7 participants: 24 to 26 months of treatment	Not described	Female: 23 patients Male: 6 patients Diabetes mellitus: 2 patients Corticosteroid drug therapy: 8 patients	Antibiotic therapy was supplemented in 13 patients Bone sequestrectomy was performed in 7 patients during teripartida therapy and in 6 patients after the therapy was completed. Biphosphonate route of administration: oral and intravenous Type of drug causing MRONJ	Adverse effects developed in 5 patients. Only one participant discontinued treatment with teriparatide due to the development of arthralgia. Nausea (24.4%), vomiting (13.4%), headache (11.1%), malaise (10.2%), renal dysfunction, internal stigma, and arthralgia were observed. According to records of teriparatide in the literature, it has a 49.5% incidence of adverse reaction development. In this study, only 17.2% of the incidence of development of adverse effects was recorded

H Kakehashi et al. 2015	Case series (preliminary study)	Teriparatide Bone anabolic agent used in osteoporosis. Physiological mechanism: stimulates bone formation by reabsorbing calcium and excreting phosphate, and indirectly increasing intestinal absorption of calcium by producing 1,25-dihydroxyvitamin D. Daily injection first stimulates bone formation, followed by bone remodeling and thus increasing bone mineral density	The following symptoms and signs were studied: pain, pus drainage, exposure of necrotic bone, in addition to desensitization of the CTX biomarker (marker of bone formation). In 7 patients, there was a complete resolution of the case, with total coverage of the exposed bone by mucosa. In 5 stage 2 patients, sequestrectomy was performed during the first 7 months of treatment with teriparatide, in all cases there was bone regeneration surrounding the lesion. In 2 stage 3 patients, curettage of the alveolus was required for healing, in these cases, small pieces of bone sequestration had to be removed by local irrigation, and adequate healing and total coverage of the exposed bone was achieved, but one of them did not have resolution of intraoral fistula, despite the fact that after a year of treatment with teriparatide the local pain disappeared. It was decided to stop treatment with this drug as there was no improvement in bone density (the study considers that teriparatide had no effect on this patient) Participants: 8 No resolution: 1	Stage 2: 7 patients Stage 3: 3 patients	20 ug/day	Range from 4 to 24 months, average 12.4 months.	Not described	Female: 10 patients Diabetes Mellitus (3 patients) Corticosteroid therapy (5 patients)	Event that triggered MRONJ: Tooth extraction - development of periodontitis	2 patients had adverse effects associated with the use of teriparatide and had to drop out of the study. One of them presented facial and lower extremity edema, nausea and vomiting on the third day of administration of teriparatide. The second patient developed arthralgia in the knees after one week of administration of teriparatide
Pelaz, Alej et al 2014	Pilot study	No describe	1 participant out of 4 showed complete resolution of the picture. 2 participants had asymptomatic bone exposure (partial resolution) 1 participant had symptomatic bone exposure (no resolution)	Stage 3	Daily dose of 20 ug	Between 4 to 10 months. Average time of 6 months	12 to 24 months	Osteoporosis: 4 participants Rheumatoid arthritis: 2 participants All patients were female MRONJ located in the mandible	Previous surgery in 2 patients	Negative adherence to treatment due to the development of psychological problems: 1 participant
Dos Santos Ferreira L 2021.	Systematic review	The action of PT occurs by intermittent stimulation of PTH 1 receptors in osteoblasts and their precursors, which stimulates the anabolic action of bone over catabolic action	66 people (60.5%) showed complete resolution of the lesions, 20 (18.3%) partial resolution, 23 (21.1%) showed no resolution. Participants: 109	Stage 2: 68 Stage 3: 27 Stadium 1: 14 Stadium 0: 2	20 ug/day	Average Time: 7.3 months	0.1 to 24 months, with an average of 8.7 months of follow-up	Female: 91 Male: 20 Systemic conditions: diabetes (32), rheumatoid arthritis (12), smoking (12), hypertension (7), alcohol consumption (8), cardiovascular disease (2), hypercholesterolemia (2), renal failure (1), gastrointestinal disease (2). Previous condition for which the use of BF was indicated: Osteoporosis (49), malignancy (13), osteopenia (1). Female (91) and male (20). Location of MRONJ: maxilla (22), mandible (75).	MRONJ triggering factor: extraction (50), implants (9), periodontitis (7), spontaneous (15). Administration route of antiresorptive drug: oral (85), intravenous (4)	2 people developed adverse effects (1.8%)

T A B L E 3 Characteristics of the studies, clinical outcomes and adverse effects.

3.2 | Clinical Results

Just one study had 100% complete resolution of the disease. However, if we look at the total number of patients who received treatment, 60.8% had complete resolution of the condition and just 31 patients (18.7%) had no resolution of the disease (Table III).

3.3 | Adverse Results

5 studies reported adverse results. None of them reported complicated adverse effects. Most of the signs and symptoms developed were nausea, vomiting, headache and myalgia. Just one study reported that one patient developed psychological problems and had to drop out (Table III).

4 | DISCUSSION

For patients who do not respond to conventional MRONJ treatments, the option of treating with teriparatide, which is described as an effective alternative because of its anabolic action on bone, has recently been added[7, 10]. Oral administration of antiresorptive drugs deliver better results before teriparatide treatment for resolution of MRONJ lesions even in advanced stages, a relationship suggesting that teriparatide has high potential as an alternative treatment to surgical interventions for MRONJ[11]. In preclinical studies in rats, it was found that the administration of teriparatide for the treatment of drug-associated osteonecrosis of the jaws favored the formation and maturation of bone tissue, allowing the healing of bone and mucosal lesions, with favorable clinical results in 40% to 72% of cases, depending on the stage of osteonecrosis[12, 13]. It is described that the use of daily and weekly doses of teriparatide improves the stages of osteonecrosis, with complete or partial resolution in 83% and 50%, respectively[14, 15].

The serum level of vitamin D before, during, and after teriparatide treatment is a factor to consider[14]. According to this study, patients with higher 25 (OH)D levels demonstrated better clinical outcomes. They also highlighted that low 25 (OH)D levels may be related to poor bone remodeling recovery during teriparatide treatment. A vitamin D deficit is related to trigger diseases related to bone metabolism, including MRONJ after dental trauma or spontaneously caused when antiresorptive drugs are consumed[15]. In participants who did not respond to teriparatide treatment, it was due to prior intravenous bisphosphonate therapy[16, 17, 18, 19]. Another study did not mention the causes of 20.7% of unresolved lesions[18]. Regarding risk factors for the use of teriparatide in MRONJ, when analyzing the relationship between teriparatide and diabetes mellitus, diabetes mellitus is only associated with a risk factor when it is not controlled, as well as excessive alcohol consumption, smoking, periodontitis and poor oral hygiene[20, 21, 22]. Corticosteroid therapy is reported to be a negative factor for the results of teriparatide in the treatment of MRONJ, reporting that its intake during teriparatide treatment attenuates the efficacy of this drug[11]. On the other hand, the suppressive effect of corticosteroids on the anabolic effect of teriparatide on bone tissue is also reported[16]. In relation to the adverse effects related to the use of teriparatide, vomiting, abdominal discomfort, constipation, pain at the injection site, myalgia, arthralgia and jaw pain were described in 86.7%. In the control group, adverse effects were described in 73.3% of patients, so it is not possible to make a direct association between adverse effects and teriparatide use(19). In another study, adverse effects were reported in 5 patients (17.8%) where the most frequent was vomiting, followed by headache, malaise and renal dysfunction. In addition, one of the patients had to abandon teriparatide treatment as he developed arthralgia(11). A similar situation occurred in another study, where 1 patient had to drop out of the study due to development of facial and lower extremity edema, as well as nausea and vomiting; a second patient also dropped out of the study due to development of arthralgia[16]. According to the Food and Drug Administration (FDA), teriparatide presents adverse effects in 16% of cases, including arthralgia, pain and nausea. According to information provided by the Public Health Institute of Chile, the most frequent adverse reactions are nausea, pain in the extremities, headache, dizziness, vertigo, depression and dyspnea[23]. On the other hand, studies in rats, describe an increased risk of osteosarcoma depending on the dose and duration of treatment. For this reason, the FDA recommends not to administer the drug for a period longer than 2 years and in patients with risk factors for the development of osteosarcoma[23, 24]. The

treatment of drug-associated osteonecrosis of the jaws (ONMAM) remains a significant clinical challenge, especially in patients receiving bisphosphonates and RANKL ligand inhibitors. Emerging evidence suggests that teriparatide may offer a promising alternative to enhance bone regeneration in patients with ONMAM. Several studies have shown that its ability to stimulate bone formation has the potential to counteract the adverse effects of the inhibition of bone turnover that characterizes ONMAM. However, significant gaps persist in the literature, particularly regarding dose standardization, treatment duration, and long-term efficacy[25]. Overall, although initial findings are encouraging, additional and larger scale controlled clinical studies are required to fully validate the role of teriparatide in the management of ONMAM. Only through future research will we be able to establish evidence-based treatment protocols that maximize the benefits of this intervention and minimize the risks to patients. This paper highlights the need for continued research in this field to optimize the management of ONMAM and improve clinical outcomes in this patient population.

5 | FINANCING

None

6 | CONFLICT OF INTERESTS

Authors declare that they have no conflicts of interest and have received no funding for this study

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