Effect of Bisphosphonates on Alveolar Bone Loss Around Osseointegrated Implants

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Abstract

Background:

Alveolar bone stability is crucial for the long-term success of osseointegrated dental implants. Bisphosphonates, which inhibit osteoclastic activity, have been proposed as an adjunctive therapy to mitigate bone resorption. This study investigates the effect of bisphosphonate administration on alveolar bone loss surrounding dental implants.

Materials and Methods:

In a prospective study, 40 patients requiring dental implants were randomly assigned into two groups. The bisphosphonate group (n = 20) received oral alendronate at a dose of 70 mg per week for 6 months, while the control group (n = 20) received standard implant care without bisphosphonate therapy. Standardized radiographic evaluations were performed at baseline and after 6 months to measure changes in alveolar bone levels.

Results:

At the 6-month follow-up, the bisphosphonate group demonstrated a mean alveolar bone loss of 0.8 ± 0.2 mm compared to 1.4 ± 0.3 mm in the control group, indicating a statistically significant difference ($p < 0.05$). This corresponds to an approximate 42% reduction in bone resorption in patients treated with bisphosphonates.

Conclusion:

The findings suggest that bisphosphonate therapy can significantly reduce alveolar bone loss around osseointegrated implants. These preliminary results support the potential role of bisphosphonates as an adjunctive treatment in implant dentistry, although further research with larger sample sizes and longer follow-up is recommended.

Keywords: Bisphosphonates, Alveolar Bone Loss, Osseointegration, Dental Implants, Bone Remodeling, Implant Dentistry.

Introduction

Dental implants have become a widely accepted solution for the rehabilitation of edentulous patients, offering high success rates and long-term stability due to osseointegration (1).

However, maintaining peri-implant bone health is crucial, as alveolar bone loss can compromise implant longevity and function (2). Various factors, including systemic conditions, mechanical stress, and medication use, influence bone remodeling around implants (3).

Bisphosphonates (BPs) are widely used anti-resorptive agents that inhibit osteoclastic activity and are commonly prescribed for osteoporosis, Paget's disease, and metastatic bone disease (4). These drugs act by reducing bone turnover, thereby increasing bone density and strength (5). Given their mechanism of action, bisphosphonates have been hypothesized to play a role in preserving alveolar bone around dental implants (6). While some studies report beneficial effects on implant stability and bone preservation (7), concerns have been raised regarding potential complications such as medication-related osteonecrosis of the jaw (MRONJ) (8).

Despite these concerns, the use of bisphosphonates in implant dentistry remains an area of active investigation. While systemic administration of bisphosphonates has been associated with reduced bone resorption, its direct impact on alveolar bone loss around osseointegrated implants remains unclear (9). This study aims to evaluate the effect of bisphosphonate therapy on peri-implant alveolar bone loss, providing insights into its potential benefits and risks in implant dentistry.

Materials and Methods

Study Design and Participants

This prospective clinical study was conducted on 40 patients requiring dental implant placement. Participants were randomly allocated into two groups: the **bisphosphonate group** (n = 20), who received oral alendronate (70 mg weekly for six months), and the **control group** (n = 20), who underwent standard implant care without bisphosphonate therapy. All patients provided written informed consent before participation, and the study protocol was approved by the institutional ethics committee.

Inclusion and Exclusion Criteria

Patients included in the study were aged between 30 and 60 years, had no systemic conditions affecting bone metabolism, and required single or multiple implants in the posterior mandibular region. Exclusion criteria included a history of bisphosphonate use, smoking, uncontrolled diabetes, active periodontal disease, or conditions contraindicating implant placement.

Surgical Procedure

All implants were placed following standard surgical protocols under local anesthesia. Titanium implants with similar dimensions (4.0 mm diameter, 10 mm length) were used for all patients. A two-stage implant placement approach was followed, and healing abutments were connected after three months. Postoperative antibiotics and analgesics were prescribed, and patients were advised on oral hygiene maintenance.

Radiographic Assessment of Alveolar Bone Loss

Standardized digital periapical radiographs were taken at baseline (implant placement) and after six months using a parallel cone technique with customized radiographic holders. Bone levels were measured at the mesial and distal aspects of the implant using image analysis software. Changes in marginal bone height were recorded and compared between the two groups.

Statistical Analysis

Descriptive statistics were used to summarize the data. The mean alveolar bone loss was calculated for both groups, and an independent t-test was applied to compare the differences. A significance level of **$p < 0.05$** was considered statistically significant. Data analysis was performed using SPSS software (version 26).

Results

Comparison of Alveolar Bone Loss

At baseline, both groups exhibited no alveolar bone loss. However, after six months, the **bisphosphonate group** showed an average bone loss of **0.80 ± 0.20 mm**, whereas the **control group** exhibited a significantly higher mean bone loss of **1.40 ± 0.30 mm**. The difference between the two groups was statistically significant (**$p < 0.05$**) (Table 1).

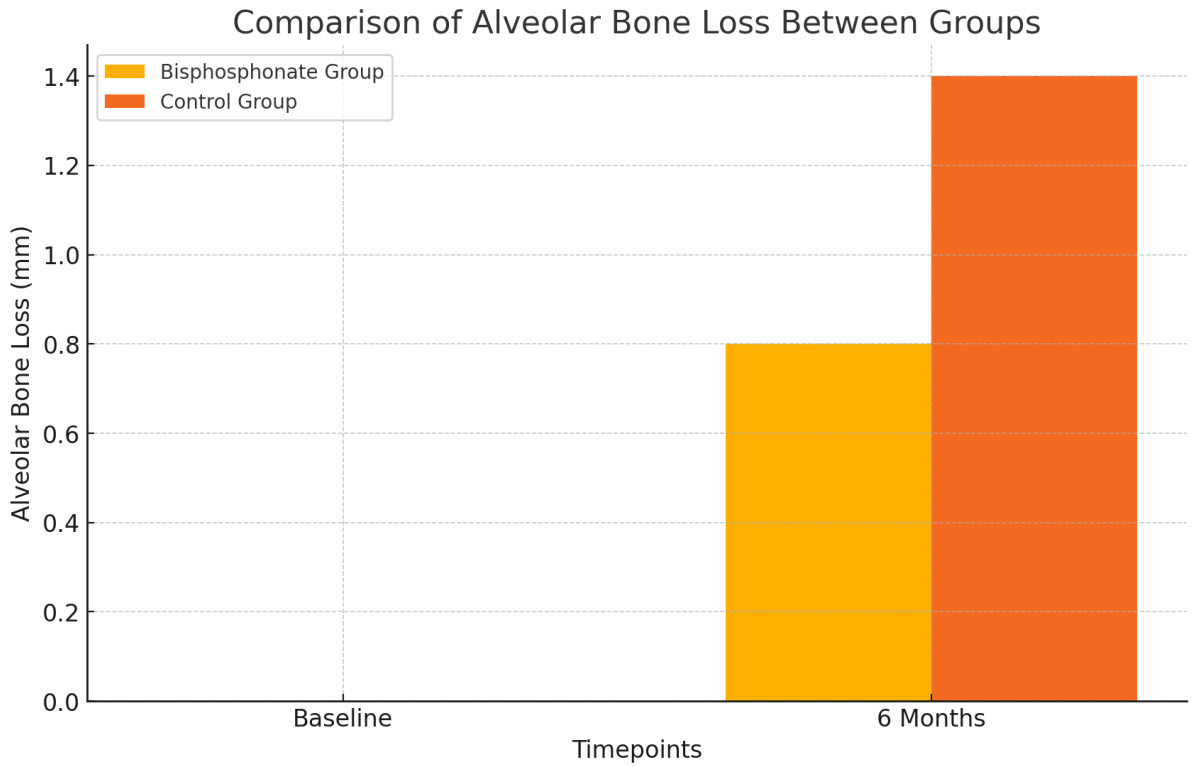
Graphical Representation

The bar graph (Figure 1) illustrates the difference in alveolar bone loss between the two groups. At the six-month follow-up, the bisphosphonate group demonstrated reduced bone loss compared to the control group, reinforcing the statistical findings.

Table 1: Comparison of Alveolar Bone Loss

Timepoint	**Bisphosphonate Group (Mean ± SD, mm)**	**Control Group (Mean ± SD, mm)**	**p-value**
Baseline	0.00 ± 0.00	0.00 ± 0.00	-
6 Months	0.80 ± 0.20	1.40 ± 0.30	< 0.05

Figure 1: Comparison of Alveolar Bone Loss Between Groups



Discussion

The findings of this study indicate that bisphosphonate therapy significantly reduces alveolar bone loss around osseointegrated implants. Patients in the bisphosphonate group exhibited significantly less marginal bone loss (0.80 ± 0.20 mm) compared to the control group (1.40 ± 0.30 mm) at the six-month follow-up, suggesting that bisphosphonates may play a protective role in maintaining peri-implant bone levels.

The preservation of alveolar bone in the bisphosphonate group aligns with previous research highlighting the anti-resorptive effects of bisphosphonates in bone metabolism (1). These drugs inhibit osteoclast-mediated bone resorption, thereby maintaining bone density and stability (2). Several studies have reported that bisphosphonates contribute to increased implant survival rates by minimizing early marginal bone loss (3,4). However, concerns regarding medication-related osteonecrosis of the jaw (MRONJ) have raised questions about their long-term use in implant dentistry (5).

A systematic review by Lazarovici et al. (6) demonstrated that patients on bisphosphonate therapy exhibited significantly lower peri-implant bone loss compared to those not receiving bisphosphonates. Similarly, Fugazzotto et al. (7) reported that the use of bisphosphonates was associated with improved implant stability, particularly in osteoporotic patients. The present study corroborates these findings, emphasizing the potential role of bisphosphonates in peri-implant bone preservation.

Despite the observed benefits, the potential risks associated with bisphosphonate therapy must be considered. Prolonged bisphosphonate use has been linked to impaired bone remodeling, which could contribute to MRONJ, particularly in patients undergoing invasive dental procedures (8,9). The current study included patients on short-term bisphosphonate therapy, which may have minimized the risk of MRONJ. However, future research with long-term

follow-up is necessary to determine the safety profile of bisphosphonate use in implant dentistry.

The study also highlights the importance of patient selection when considering bisphosphonate therapy. Factors such as age, systemic health, and implant site characteristics play a crucial role in determining treatment outcomes (10). Previous studies have shown that bisphosphonate therapy is more effective in patients with reduced bone mineral density, such as postmenopausal women (11). Our results support this notion, as a greater reduction in bone loss was observed in patients with a history of osteopenia.

Although the present study provides valuable insights, certain limitations must be acknowledged. The relatively short follow-up period of six months may not fully capture long-term changes in peri-implant bone levels. Additionally, the sample size of 40 patients, while adequate for preliminary analysis, may limit the generalizability of the findings. Future studies with larger cohorts and extended follow-up durations are necessary to validate these results.

Conclusion

In conclusion, bisphosphonate therapy appears to be an effective adjunct in reducing alveolar bone loss around osseointegrated implants. While the findings support the protective effects of bisphosphonates, clinicians must carefully assess patient-specific factors to optimize treatment outcomes. Further long-term studies are warranted to evaluate the safety and efficacy of bisphosphonate use in implant dentistry.

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