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Effect of osteoporosis on implant stability and peri-implant bone changes

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Abstract:
Osteoporosis may adversely affect peri-implant bone remodeling and osseointegration, potentially compromising implant stability and long-term treatment outcomes. This prospective comparative study evaluated 100 patients, including 50 healthy and 50 osteoporotic patients, by assessing implant stability using resonance frequency analysis and peri-implant marginal bone loss radiographically over 6 months. Osteoporotic patients showed significantly lower implant stability quotient values and greater marginal bone loss than healthy controls ($p<0.05$), while implant survival remained high and comparable between groups. Osteoporosis negatively affected implant stability and peri-implant bone remodeling without significantly compromising implant survival during follow-up. These findings advance knowledge by supporting careful patient selection, appropriate treatment planning and close follow-up to achieve predictable implant outcomes in patients with osteoporosis.

Keywords: Osteoporosis, dental implants, osseointegration, implant stability quotient, peri-implant bone loss, bone mineral density

Background:
Dental implant therapy is a predictable and well accepted treatment modality for the replacement of missing teeth and long-term success is largely dependent on the success of osseointegration and maintenance of peri-implant bone. Osseointegration is a dynamic biological process, which is affected by the implant design, surgical skill, bone quality/quantity and systemic diseases. There has been much interest in the systemic diseases that can affect the bone remodelling and stability of implants as is common with osteoporosis **[1].** Osteoporosis is a chronic skeletal disorder where the bone mineral density (BMD) or the microarchitecture of bones is reduced leading to increased bone fragility and fracture risk. Its prevalence is higher in elderly people or post-menopausal women, who are also societies that are increasingly interested in implant supported prosthetic rehabilitation. Less bone mass and changes in bone turnover in osteoporotics are theoretically considered to affect implant osseointegration, primary stability and increase the rate of peri-implant bone loss **[2].** There have been several systematic review studies that assessed the association between osteoporosis with the outcomes of dental implants. Survival rates of implants placed for an osteoporotic patient are generally good, but there is no consistent evidence about implant stability or peri-implant marginal bone changes **[3].** A systematic review and meta-analysis found no significant difference in implant survival between patients with and without osteoporosis, although marginal bone loss was greater in the osteoporosis group **[4].** A few studies have found no difference in implant survival between osteoporotics and healthy individuals, while others have indicated higher rate of marginal bone loss and slower osseointegration rate in poor bone metabolic condition patients **[5].** Recent findings also suggest that important factors for successful implant osseointegration include nutritional status, calcium and vitamin D intake and systemic bone metabolism. Even patients with lower bone density may benefit from implant healing thanks to the proper dietary choices and the maintenance of healthy bones **[6].** Vitamin D deficiency has also been associated with impaired osseointegration and increased early implant failure, although further trials are needed to define the benefit of supplementation **[7].** Moreover, experimental osteoporotic animal models have led to the current understanding of the biological mechanisms responsible for poorer bone repair and implant osseointegration behaviour under osteoporotic conditions **[8, 9].** Current osteoporosis management includes antiresorptive and osteoanabolic therapies, with individualized risk stratification recommended for long-term bone-health management **[10].** In a rodent model, oestrogen deficiency was associated with reduced peri-implant bone density and bone-to-implant contact, while mechanical loading attenuated some of these changes **[11].** Therefore, it is of interest to assess the effect of osteoporosis on stability of dental implants and peri-implant bone status after dental implant placement.

Materials and Methodology:
Study design:
This was a prospective comparative observational study to assess the effect of osteoporosis on the stability of dental implants and the peri implant bone changes after its placement.

Study setting:

The study was carried out in the Dept. of Prosthodontics and Implantology in co-operation with the Department of Oral and maxillofacial radiology with the approval from the "Institutional ethics committee" (IEC) of tertiary care dental teaching hospital.

Study duration:
The patient recruitment, implant placement and follow-up assessment period for the study was 24 months.

Sample size:
Overall, 100 patients who needed dental implant rehabilitation treatment were studied

Group I (Osteoporosis): consisted of 50 patients who were diagnosed with osteoporosis based on DEXA (T-score ≤ –2.5).
Group II (Control): 50 patients (sex and age matched) with normal BMD (T score ≥ –1.0).

Study population:
After giving informed written consent, patients who met the criteria were accepted for the study after having been diagnosed with partial edentulism and needed implant-supported prosthetic rehabilitation.

Inclusion criteria:
[1] Patients aged 40–75 years.
[2] Patients that are in need of one or more dental implants.
[3] Enough alveolar bone for placement of implants without significant grafting operations.
[4] Group I had a DEXA scan and was diagnosed with osteoporosis.
[5] Patients were agreeable to participate and comply follow up.

Exclusion criteria:
[1] Uncontrolled diabetes mellitus.
[2] Heavy smokers (>10 cigarettes/day).
[3] History of head & neck Radiotherapy
[4] Long-term use of corticosteroid and/or immunosuppressive drugs.
[5] Untreated periodontal disease.
[6] Other metabolic bone diseases than osteoporosis.
[7] Pregnancy or lactation.
[8] IV bisphosphonate therapy patients.

Study procedure:
Prior to the placement of implants, all patients in this study were given a thorough medical and dental history, comprehensive clinical examination and cone-beam computed tomography (CBCT) evaluation. Bone mineral density was measured by DEXA scans. The same sized implants with the same kind and surface were inserted in the same surgical manner by highly trained implant surgeons in local anesthesia. Torque in which the implants were inserted was documented at the time of surgery. ISQ value was obtained performed to evaluate primary implant stability immediately after the implants were placed (using Resonance Frequency Analysis procedure-Osstell device). Secondary stability was evaluated at three and six months after implant placement, once again using the same technique. Standardized digital intraoral radiograph or CBCT of peri-implant marginal bone levels was assessed after implant placement (baseline) at 3 months and 6 months post-implant placement. The amount of mesial and distal marginal bone change was estimated by calibrated imaging software and the mean value of marginal bone change was determined.

Outcome measures:
Primary outcomes:
[1] Implant Stability Quotient (ISQ)
[2] Change in stability of implant with time.
[3] Peri-implant marginal bone loss (mm).

Secondary outcomes:
[1] Implant survival rate
[2] Early implant failure
[3] Peri-implant soft tissue health (Plaque Index, Bleeding on Probing, & Probing Depth)

Statistical analysis:
All data were entered into MS-Excel formats and then analyzed in SPSS 26.0 software (IBM Corp., Armonk, NY, USA). Data of continuous variables were reported as mean ± standard deviation and those of categorical variables were reported as frequency and percentage. The independent two-sample Student's t or Mann–Whitney U test were used to carry out intergroup comparisons. Performance of implants and efficacy of peri-implant bone changes following different follow-ups were compared using repeated measures ANOVA. Chi-square or Fisher's exact test was used for categorical variables. A p-value of less than 0.05 was deemed as being statistically significant.

Results:
A total of 100 patients were included, with 50 in the osteoporosis group and 50 in the control group. The two groups were comparable at baseline with respect to age, sex, BMI and implant location, with no statistically significant differences ($p > 0.05$ for all comparisons) **(Table 1).** Mean ISQ values increased in both groups from implant placement to 6 months. However, the osteoporosis group had significantly lower ISQ values than the control group at immediate placement (66.9 ± 4.8 vs 70.4 ± 4.5, $p = 0.001$), 3 months (70.8 ± 4.3 vs 75.2 ± 4.0, $p < 0.001$) and 6 months (74.1 ± 3.8 vs 78.6 ± 3.6, $p < 0.001$) **(Table 2).** Peri-implant marginal bone loss increased in both groups during follow-up. It was significantly greater in the osteoporosis group than in controls at 3 months (0.42 ± 0.16 vs 0.28 ± 0.13 mm, $p = 0.001$) and 6 months (0.78 ± 0.22 vs 0.49 ± 0.19 mm, $p < 0.001$) **(Table 3).** At 6 months, implant survival was 96.0% in the osteoporosis group and 100.0% in the control group, with no statistically significant difference ($p = 0.153$). Plaque index ($p = 0.194$) and bleeding on probing ($p = 0.317$) were similar between groups. Probing depth was significantly greater in the osteoporosis group (2.82 ± 0.47 vs 2.51 ± 0.42 mm, $p = 0.001$) **(Table 4).**

Table 1: Baseline demographic characteristics of the study participants

Variable	Group I (Osteoporosis) (n=50)	Group II (Control) (n=50)	p-value
Mean age (years)	61.8 ± 7.1	59.9 ± 6.8	0.176
Female, n (%)	39 (78.0)	37 (74.0)	0.642
Male, n (%)	11 (22.0)	13 (26.0)	
BMI (kg/m²)	24.7 ± 2.9	24.1 ± 3.1	0.318
Maxillary implants, n (%)	28 (56.0)	26 (52.0)	0.688
Mandibular implants, n (%)	22 (44.0)	24 (48.0)	

Table 2: Comparison of implant stability quotient (ISQ) between the groups

Follow-up	Group I (Osteoporosis)	Group II (Control)	p-value
Primary stability (Immediate)	66.9 ± 4.8	70.4 ± 4.5	0.001
3 months	70.8 ± 4.3	75.2 ± 4.0	<0.001
6 months	74.1 ± 3.8	78.6 ± 3.6	<0.001

Table 3: Comparison of peri-implant marginal bone loss (mm)

Follow-up	Group I (Osteoporosis)	Group II (Control)	p-value
Baseline	0.00 ± 0.00	0.00 ± 0.00	–
3 months	0.42 ± 0.16	0.28 ± 0.13	0.001
6 months	0.78 ± 0.22	0.49 ± 0.19	<0.001

Table 4: Implant survival and peri-implant clinical parameters at 6 months

Variable	Group I (n=50)	Group II (n=50)	p-value
Implant survival, n (%)	48 (96.0)	50 (100.0)	0.153
Early implant failure, n (%)	2 (4.0)	0 (0.0)	0.153
Plaque Index	0.84 ± 0.31	0.76 ± 0.28	0.194
Bleeding on Probing (%)	12 (24.0)	8 (16.0)	0.317
Probing depth (mm)	2.82 ± 0.47	2.51 ± 0.42	0.001

Discussion:

This is a prospective comparative study on the effect of osteoporosis on implant stability and peri-implant bone changes in the patients undergoing dental implant therapy. Patients with osteoporosis did have lower implant stability values and more peri-implant marginal bone loss at every time point during the follow-up period, although the survival rate for implants in the two groups remained high. Gong *et al.* reported that older adults with lower peri-implant bone density had lower implant stability and higher early failure rates than younger patients **[12].** Recent results indicate that osteoporosis may negatively affect the osseointegration and peri-implant bone remodelling in the long term, even when good short-term results have been obtained. The peri-implant bone characteristics during the first year after bone augmentation revealed by an AI-assisted radiographic assessment showed a significant correlation with the primary implant stability, which was comparable to healthy individuals, although bone metabolism was found to be different, supporting the high prevalence of peri-implant diseases reported by Garay *et al.* in osteoporotic patients **[13].** The prospective case-series study by Elena *et al.* indicated that radiographic peri-implant degenerative changes were observed during the first 1 year after implant placement in osteoporotic women and therefore suggested ongoing alterations in bone remodelling in osteoporotic patients after implant placement, which may affect long-term peri-implant bone maintenance in these patients **[14].** The one-year prospective study by Cho *et al.* showed successful osseointegration of implants in postmenopausal women with osteoporosis, but the radiographic peri-implant bone changes indicated continuous changes in the bone remodelling status during that period which could affect long-term peri-implant bone properties in individuals with osteoporosis **[15].** Xiao *et al.* found a significant correlation between primary implant stability and peri-implant bone mineral density using an AI-assisted radiographic assessment, showing that bone quality is of paramount importance for the attainment of optimal implant stability and thus advocating for peri-implant bone quality assessment during the planning phase of dental implant placement **[16].** In the present study, the effect of osteoporosis on implant stability and marginal bone on implants was significant; however, the overall implant survival was good. According to Romandini *et al.*, this means that peri-implant disease is a multifactorial problem, not only systemic disease, but it also relies on the plaque control, maintenance therapy and medical risk factors of the patient and individuals; therefore it is important to perform a comprehensive periodontal diagnosis and choose a long-term supportive therapy to reduce peri-implant disease in medical disease patients **[17].** EFP S3 clinical practice guideline by Sanz *et al.* also underlined the importance of a thorough periodontal examination and the use of long-term supportive periodontal therapy, reducing peri-implant disease even in patients with a medical disease to reduce peri-implant disease **[18].** Probing depth was slightly higher among the osteoporotic patients, while the soft tissue parameters around the implant were similar for both groups in the present study. According to Renvert and Polyzois, another major cause for peri-implant mucositis, not only in the context of bone status, but in general is plaque accumulation and inadequate maintenance **[19].** There were essentially no differences in any soft tissue around the implant parameters between groups in the present study, with only probing depth showing a slight difference with a higher probing depth seen among osteoporotic patients. Significant marginal bone loss around implants was also reported by Kim *et al.*, who found that the Implant Stability Quotient (ISQ) values were significantly lower in the osteoporotic individuals, finding this parallel with the present report implying that treatment planning, adequate surgical technique and regular follow-up are therefore of supreme importance for predictable long-term outcomes when treating patients who are osteoporotic, even if the absence of systemic metabolic disorders were not taken into consideration **[20].** In addition, Shibli *et al.* and Sachelarie *et al.* in their systematic review, reported that there is an increased risk of peri-implant mucositis when bone loss occurs after implant placement, which is another similarity with the present study, indicating that careful treatment planning, adequate surgical technique and regular follow-up are of supreme importance to ensure predictable long-term outcomes both in the presence and absence of systemic metabolic disorders when treating osteoporotic patients **[2, 21].** The present outcomes suggest that the stability of the implants may not be obtained as quickly and the level of peri-implant bone remodelling may be increased, due to osteoporosis. However, proper patient selection and maintenance will still allow successful implant rehabilitation. A recent narrative review similarly concluded that osteoporosis alone should not be considered an absolute contraindication to

implant therapy, although patients receiving antiresorptive medication require individualized risk assessment **[22].**

Conclusion:

Osteoporosis was associated with lower ISQ values and greater peri-implant marginal bone loss at 3 and 6 months than normal bone mineral density. Implant survival was high in both groups and did not differ significantly at 6 months. Careful patient selection, surgical technique and regular maintenance may support favourable implant outcomes in osteoporotic patients.

References:

[1] Corgel JO. *Periodontol 2000.* 2012 **59**:111. [PMID: 22507063]
[2] Shibli JA *et al. Quintessence Int.* 2025 **56**:206. [PMID: 39804249]
[3] Giro G *et al. World J Orthop.* 2015 **6**:311. [PMID: 25793172]
[4] Lemos CAA *et al. Clin Oral Investig.* 2023 **27**:2483. [PMID: 37043030]
[5] de Medeiros FCFL *et al. Int J Oral Maxillofac Surg.* 2018 **47**:480. [PMID: 28651805]
[6] Alsaadi G *et al. J Clin Periodontol.* 2007 **34**:610. [PMID: 17433044]
[7] Miron RJ *et al. Periodontol 2000.* 2025. [PMID: 41163589]
[8] Sodnom-Ish B *et al. Int J Implant Dent.* 2026 **12**:23. [PMID: 41936654]
[9] Calciolari E *et al. J Invest Surg.* 2017 **30**:342. [PMID: 27929692]
[10] Sølling AS *et al. Annu Rev Med.* 2026 **77**:433. [PMID: 41252575]
[11] Chen X *et al. J Mech Behav Biomed Mater.* 2021 **123**:104771. [PMID: 34438251]
[12] Gong T *et al. Int Dent J.* 2025 **75**:103942. [PMID: 41110400]
[13] Garay CJE *et al. J Oral Maxillofac Res.* 2025 **16:**e1. [PMID: 41357364]
[14] Elena C *et al. Clin Oral Implants Res.* 2025 **36**:1234. [PMID: 40625220]
[15] Cho JM *et al. Int J Implant Dent.* 2025 **11**:41. [PMID: 40411611]
[16] Xiao Y *et al. Sci Rep.* 2024 **14**:3009. [PMID: 38321110]
[17] Romandini M *et al. Clin Oral Implants Res.* 2021 **32**:112. [PMID: 33210772]
[18] Sanz M *et al. J Clin Periodontol.* 2020 **47**:4. [PMID: 32383274]
[19] Renvert S & Polyzois I. *J Clin Periodontol.* 2015 **42**:S172. [PMID: 25496066]
[20] Kim SY *et al. J Clin Med.* 2025 **14**:6719. [PMID: 41095799]
[21] Sachelarie L *et al. Medicina (Kaunas).* 2025 **61**:74. [PMID: 39859055]
[22] Paijas K *et al. Int J Drug Deliv Technol.* 2026 **16**:1803. [DOI: 10.25258/ijddt.16.84s.184]

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