

Low Skeletal Bone Mineral Density Does Not Affect Dental Implants

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The aim of this case-control study (n = 30) was to evaluate the effects of osteoporosis/osteopenia on the success of dental implants. Twenty healthy females ages 50–80 with confirmed osteoporosis or osteopenia, and 10 age- and gender-matched subjects with normal bone density (controls) received dental implants. Dual-energy X-ray absorptiometry (DXA) scans at 5 standard sites (total body, hip, spine [lateral and anterior-posterior] and radius) were measured at baseline and 24 months. Periapical and panoramic radiographs were taken at baseline before implant placement; 1 periapical radiograph was taken immediately after placement of the dental implant. Since implants are standard sizes, periapical bone loss was measured from the first implant thread to the level of alveolar bone at baseline, 12 months, and 24 months via 1 periapical radiograph. All subjects received implants of the same manufacturer (NobelBiocare). One subject was a smoker. Three subjects with osteoporosis had received prior treatment with Fosamax, 1 received Fortical, and 1 Forteo. In all 3, there was slight improvement in DXA after 24 months. All implants remained successful with no evidence of bone loss after 24 months. These investigators conclude that implants placed in individuals with confirmed skeletal osteoporosis can be successful, with no clinical differences to implants placed in healthy individuals. Although 3 subjects with osteoporosis had treatment with oral bisphosphonates, no side effects were noted and no bone necrosis of the jaw was observed. Further investigation with larger sample sizes and longer periods of time for treatment with oral bisphosphonates is recommended to confirm these results.

Key Words: bisphosphonates, osteoporosis, failure (dental implant), dental (clinical practice), bone mineral density

INTRODUCTION

Osteoporosis is a common bone-resorptive, host-dependent, multifactorial, and systemic skeletal disease generally affecting older females, marked by reduced bone strength, decreased bone mineral density and microarchitectural deterioration of bone tissue, resulting in increased bone fragility and risk of bone fracture.¹ Dental implants, meanwhile, are increasingly sought out by the same aging population. It is clinically necessary to understand the effects of skeletal low bone mineral density and treatment for osteoporosis with oral bisphosphonates on dental implant success. Most investigations conclude that no compelling theoretical or practical basis exists to expect osteoporosis to be a risk factor for osseointegrated dental implants.^{2–5}

Some implantologists^{6–8} see evidence that implant placement may be protective against alveolar bone resorption by stimulating continuous bone remodeling, and thus may actually be protective against typical oral bone loss due to the aging process. Some theorized that it is important to replace missing teeth with implants to ensure function by duplicating loading and ensuring bone density.^{9–11}

Wactawski-Wende¹² found osteoporosis related to alveolar crest height and tooth loss, but not clinical attachment level.

Tezal¹³ suggests systemic bone loss is related to alveolar bone loss, and to a lesser extent, clinical attachment loss in postmenopausal Caucasian women. Other studies report association between low bone mineral density and tooth loss in men^{14,15} and postmenopausal women.^{16,17} Postmenopausal women¹⁸ are at greater risk for mandibular bone mineral content loss than older men. For edentulous individuals, residual ridge height correlates with both total body calcium and mandibular bone mineral density.¹⁹

The objective of this research was to establish whether individuals with clinical low bone mineral density (*osteoporosis or osteopenia*) would successfully retain dental implants, and whether dental implants, like natural teeth, are protective against alveolar bone resorption through stress-bearing and occlusal load factors, which stimulate continuous bony remodeling.

MATERIALS AND METHODS

Patient selection

Thirty subjects were enrolled in this study. The research was conducted under University of Pittsburgh Institutional Review Board approved protocols, and written informed consent was obtained prior to the performance of any research procedure. Dual-energy X-ray absorptiometry (DXA) scans were performed on all subjects. Twenty individuals with prior low bone mineral density (confirmed osteoporosis/osteopenia established by report of the treating medical physician) were selected as

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cases, and 10 individuals possessing adequate bone density were enrolled as controls.

All DXA scans on all subjects were conducted on the same equipment (Hologic QDR 4500A; Hologic, Bedford, Mass) at the same facility, by the same blinded operator (D.M.), recording the same 5 standard DXA measurements for total body, hip, spine (lateral and anterior-posterior), and radius. All subjects were in good physical health except for the diagnosis of osteoporosis or osteopenia. Subjects were excluded if presenting with history of mental or legal incapacitation precluding informed consent; with history of metabolic bone disease, bone metastases, or radiation therapy of bone; or with diagnosis of hyperthyroidism or hypothyroidism within 6 months of enrollment.

All subjects received at least one dental implant of the same manufacturer and type (NobelReplace Tapered Groovy, Nobel Biocare AG grant #2007-596, Gothenburg, Sweden) at any tooth position in either the mandible or the maxilla. All implants were placed by the principal investigator (P.F.). Implants were uncovered 6 to 8 months after placement, and were restored. All subjects were followed 2 years postimplant procedure by comprehensive oral examination, receiving 1 periapical radiograph in the first and second years after the implant placement. Bone mineral DXA scans were taken at baseline and repeated at 2 years.

Periapical and panoramic radiographs were taken at baseline before implant placement, and 1 periapical radiograph was taken immediately after placement of the implant. Since the implants were all of standard sizes, bone levels were measured and recorded from the first thread to the level of alveolar bone. Measurements were repeated at 12 months and 24 months. All subjects received NobelReplace Tapered Groovy implants under local anesthesia and the surgical flap on the area was closed using 4-0 Vicryl sutures. All implants demonstrated primary stability with torque at 30 N-cm. Subjects were followed clinically for 2 years.

RESULTS

In this case-control study, 20 individuals (ages 52–70) receiving 21 implants were enrolled as cases and 10 individuals enrolled as controls received 10 implants. All subjects were females ages 50–80 and all provided written informed consent. Subjects were screened and enrolled between November 2007 and July 2011. Implants were placed between April 30, 2008, and October 2011. One case subject failed to keep research appointments after implant placement and follow-up data could not be obtained. The 20 active case implants remain functionally loaded and stable without mobility or radiographic bone loss to the time of this writing, continuing more than 5 years in the earliest and 3 years in the last case. Success among the 20 followed case implants was 100%; overall success among all implants available to follow (30) was 96%. One of the control implants failed.

Implant positions and sizes can be summarized in the following material.

Case subjects

Twelve implants were placed in the maxilla, 9 implants in the mandible. In the maxilla, 1 implant was placed at tooth position

	Baseline	Two years later	P-value
Cases			
BMD (g/cm ²)			
Total hip	0.831	0.823	.283
Femoral neck	0.705	0.694	.312
Intertrochanter	0.989	0.980	.300
Trochanter	0.626	0.621	.328
Absolute rate of change in BMD (mg/cm ² , yr)			
Total hip	-4.31		
Femoral neck	-5.31		
Intertrochanter	-4.56		
Trochanter	-2.52		
Percent rate of change in BMD (%/yr)			
Total hip	-0.52		.348
Femoral neck	-0.75		.301
Intertrochanter	-0.46		.359
Trochanter	-0.40		.368
Controls			
BMD (g/cm ²)			
Total hip	0.959		.252
Femoral neck	0.808		.288

#3; 2 at position #4 and 2 at position #5; 1 each at teeth #7, #9, #10; #13, and #14; and 2 in position #12. In the lower jaw, 3 implants were placed at position #19 and 1 each at tooth positions #18, #22, #27, #29, #30, and #31.

Implant sizes (cases)

Implant sizes were 3.5 × 10 mm (2 cases); 5 × 10 mm (4 cases); 5 × 13mm (1 case); 4.3 × 10 mm (2 cases); and 4.3 × 13 mm (3 cases).

Control subjects

Four implants were in the maxilla, 6 in the mandible. Implants in control subjects were 5 × 10 mm (at #18 and 2 at #30); 4.3 × 13 mm (at #5 and #9); 4.3 × 10 mm (at #4 and #30) and 3.5 × 13 (at #13 and #29). An additional implant size, 6 × 10 mm, was placed at #30 for 1 control subject.

The mean age for all cases and controls was 64.66 years ± 1. Only 1 subject was a smoker, and no other subjects disclosed a history of smoking. Two subjects were African-American. Three subjects reported treatment of osteoporosis with medication, 2 with oral bisphosphonates (Fosamax, Merck, Whitehouse Station, NJ) and one with calcitonin nasal spray (Fortical, Upsher-Smith Laboratories, Minneapolis, Minn). While real change (improvement/loss) in bone mineral density did occur in individual subjects, Table 1 summarizes bone mineral density percent change within 2 years following dental implant placement for all subjects, cases versus controls. No significant changes can be observed. Bone losses were measured with periapical radiographs at baseline, 12 months, and 24 months after implant placement. All implants were of the same style, type, and manufacturer (Nobel Biocare Nobel Replace Tapered Groovy, NobelBiocare, Yorba Linda, Calif), and were placed in either the mandible or maxilla. Since each subject functioned as her own control, the position of the dental implant placement was not important.



FIGURES 1–3. **FIGURE 1.** Periapical showing edentulous site prepared for subsequent implant placement. **FIGURE 2.** Periapical showing osseointegrated implant stable in bone after placement, upon uncover and prior to restoration. **FIGURE 3.** Periapical showing osseointegrated and fully restored dental implant.

DISCUSSION

Becker²⁰ examined the relationship between osteoporosis on the maxilla or mandible to predict implant success. In simple case-control research, plain visual assessment of bone quality at the implant site was more informative regarding implant failure than pDXA obtained at peripheral bones. They found no relationship between osteoporosis and failing implants. The investigators used pDXA at the distal and proximal radius and ulna, classified bone quality and quantity at placement by visualization, and asked a series of questions collecting variables that could potentially affect the outcome. There was no association between pDXA scores at the radius and ulna and the risk for implant failure, yet visual assessment of bone quality at placement showed a moderate relationship to implant failure, indicating that pDXAs of the radius or ulna are not predictive of implant failure and do not perform better than visual assessments of the jawbone on standard radiograph.

Friberg⁴ retrospectively assessed 13 implant patients referred for medical work-ups following detection of osteoporosis risk factors. During follow-up (3 years, 4 months), success for implant placement despite confirmed osteoporosis/osteopenia was still above 97% when adapted bone site preparation technique was used and given extended healing time. Implant placement could still be successful in the long-term even for patients for whom average bone density (spine and hip) indicated osteoporosis, and jawbone showed poor bone density.

This research showed that all dental implants placed were successful and were maintained 2 years despite subject bone mineral density. The strength of this study is to show that dental implants can be successfully placed and retained in patients with confirmed osteoporosis or osteopenia, and that individuals who were treated with oral bisphosphonates for periods 5 years or less can be viable candidates for dental implant placement. The investigators do recommend further investigation with larger sample sizes to confirm this finding.

One limitation of this research is our inability to use digital tomography to record results, as that technology was not available at the University of Pittsburgh School of Dental Medicine at the time. Unfortunately, due to the expense of dental implant therapy, only 10 individuals were able to be recruited for participation as control subjects. However, since dental implant size is standard, bone loss could be measured by

using the periapical radiograph at baseline and calculating from the first thread of the implant to the level of the alveolar bone. Measurements were repeated at 12 months and at 24 months. As Becker had established,²⁰ this study showed that assessment of bone loss with standard periapical radiograph is possible. All implants placed, cases and controls, were maintained 2 years without any bone loss. The periapical radiographs in Figures 1–3 document implant placement and restoration.

CONCLUSIONS

In conclusion, this research demonstrates that patients with confirmed osteoporosis or osteopenia may nevertheless have successful dental implant placement, with potential for maintenance at least 2 years. This research further demonstrates that patients taking oral bisphosphonates for periods less than 5 years may have successful dental implant placement with no side effects or bone necrosis. This limited research affirms that healthy women with systemic postmenopausal osteoporosis or osteopenia will successfully retain dental implants. This subject is clinically important to oral implantologists and requires confirmation through future prospective research with substantially larger populations and longer periods of oral bisphosphonate treatment.

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