Bone Density Evaluation *In Vivo* after Installation of Implants Using an Osteotome Technique: Case Report

Mario Santagata[1,*], Domenico Rienzo[2], Salvatore d'Amato[1], Gianpaolo Tartaro[1] and Umberto Tozzi[2]

[1]*Multidisciplinary Department of Medical and Dental Specialties. Oral and Maxillofacial Surgery Unit. AOU–SUN (Second University of Naples), Naples, Italy*

[2]*U.O.C. Anesthesia and Resuscitation, ASL CE–P.O. "San Rocco", Via Ospedale, 81037 Sessa Aurunca (CE), Italy*

Abstract: The aim of our study was to evaluate bone density before and after implant placement by the osteotome technique *in vivo* and human posterior maxilla.

Patient treated with implants placement in position of right upper canine and right first upper premolar by osteotome technique. Radiological evaluation by CBCT was performed before and 4 months after surgery.

The results showed that osteotome technique achieved a significant increase in bone density in area of right upper canine but there was not increase in area right first upper premolar. According to our results, the osteotome technique is the best choice for implant placement in posterior maxilla but only when a low bone density is present.

Keywords: Implants, osteotome technique, bone density.

INTRODUCTION

The success rate obtained with dental implants in various clinical situations depends to a great extent on the volume and quality of the surrounding bone and depends to the region treated [1, 2]. The success of this treatment is mainly associated with the primary stability of the dental implant, this being only one of the fundamental criteria for ensuring osseointegration [2].

Initial stability depends on the macro and micro-scopic design of the implant, the surgical technique and primarily on the quality of the host bone [3].

Poor quality bone (types 3 and 4 in Misch's classification) is often found in the posterior maxilla [4-6], precisely the area where the largest numbers of dental implant failures have been described in the literature [7-9].

Titanium implants with rough surface [10-12] and modified surgical techniques [13] have permitted the placement of implants in the posterior maxilla with a success rate similar to other oral regions with good quality bone. One of the surgical alternatives to the conventional drilling technique is the osteotome technique, which was initially introduced to increase the primary stability of dental implants in the posterior maxilla [14-17].

When reviewing the clinical literature of oral implants, it was found that the osteotome technique was generally carried out in combination with sinus floor elevation [18].

The greater implant success rate of the osteotome technique in the posterior maxilla without additional sinus floor elevation [19] has been attributed to, among other factors, the peri-implant trabecular condensation produced by the osteotomes on the cancellous maxi-llary bone. In literature it was reported the compression of peri-implant trabecular bone with the osteotome technique, i.e., the 'corticalization' of the implant future socket [20]. Nevertheless, to our knowledge, no bone density study in the human posterior maxilla has been performed to demonstrate a significant increase in peri-implant bone density compared to the surrounding cancellous bone as result of the osteotome technique. Likewise, we are unaware of statistical studies that have evaluated peri-implant bone density following the osteotome technique as compared with the conventional drilling technique. Hence, the aim of this study was to determine per iimplant bone condensation *in vivo* following the osteotome technique through the use of cone beam CT scan.

MATERIAL AND METHODS

Case Report

Male patient, 41 years old, without any diseases or drug therapy, but with previous radiographic and

*Address correspondence to this author at the Piazza Fuori Sant'Anna, 17-81031 Aversa (CE), Italy; Tel: +39 3331165775; Fax: +39 0815665294;
E-mail: mario.santagata@tin.it

E-ISSN: 2311-8695/15

histological diagnosis of odontogenic cysts in the area of right upper canine and right first upper premolar.

Two implants were positioned in position of right upper canine and right first upper premolar. Radiological evaluation by CBCT was performed before surgery (T0) and 4 months after surgery (T1). Misch's classification was used for evaluation of bone density [21].

Medical treatment provided: Amoxicillin + clavulanic acid 2gr 1 hour before and 6 hour after surgery in the first day, 1gr x 2/day x 2days; Clorexidina gel 3 applications / day x 10days.

Surgical Procedure

Surgery was performed under sterile conditions. In the areas exposed to surgery 2ml of local anaesthesia (2% lidocaine with 12.5mg/ml epinephrine, Xylocain/Adrenalins, Astra, Wedel, Germany) was injected. The upper right alveolar ridge was exposed by scalpel incision and mucosal flap. The osteotome technique was performed, the implant sites were prepared by pilot drill, followed by the spiral drilling of cortical bone and finally preparing the spongiosa by osteotomes of increasing diameter (Dentsply, Italy). Each instrument remained in the implant site for 1 minute before the next diameter was used. Finally, implants were inserted by using continuous external sterile saline irrigation to minimize bone damage caused by overheating. At the surgical site, the mucosa was closed with single resorbable sutures (Vicryl 4-0, Ethicon, Norderstedt, Germany). Sutures were removed after 7 days.

CT Scan Evaluation and Follow-Up

The following parameters were evaluated:

1) Preoperative bone density (time t_0);

2) Bone density at the time of abutment connection (time t_1);

Bone density, according to Misch's classification [24] was measured with a cone beam computed tomography (CBCT), Scanora 3Ds (Soredex, Tuusula, Finland). The measurements were performed at time t_0 (Figures **1-2**) and t_1 (Figure **3-4**).

Measurements of Voxel Values

Voxel values of maxillary cancellous bone were measured in CBCT images. Cross-sectional images of CBCT with a 2.0mm thickness were reconstructed in

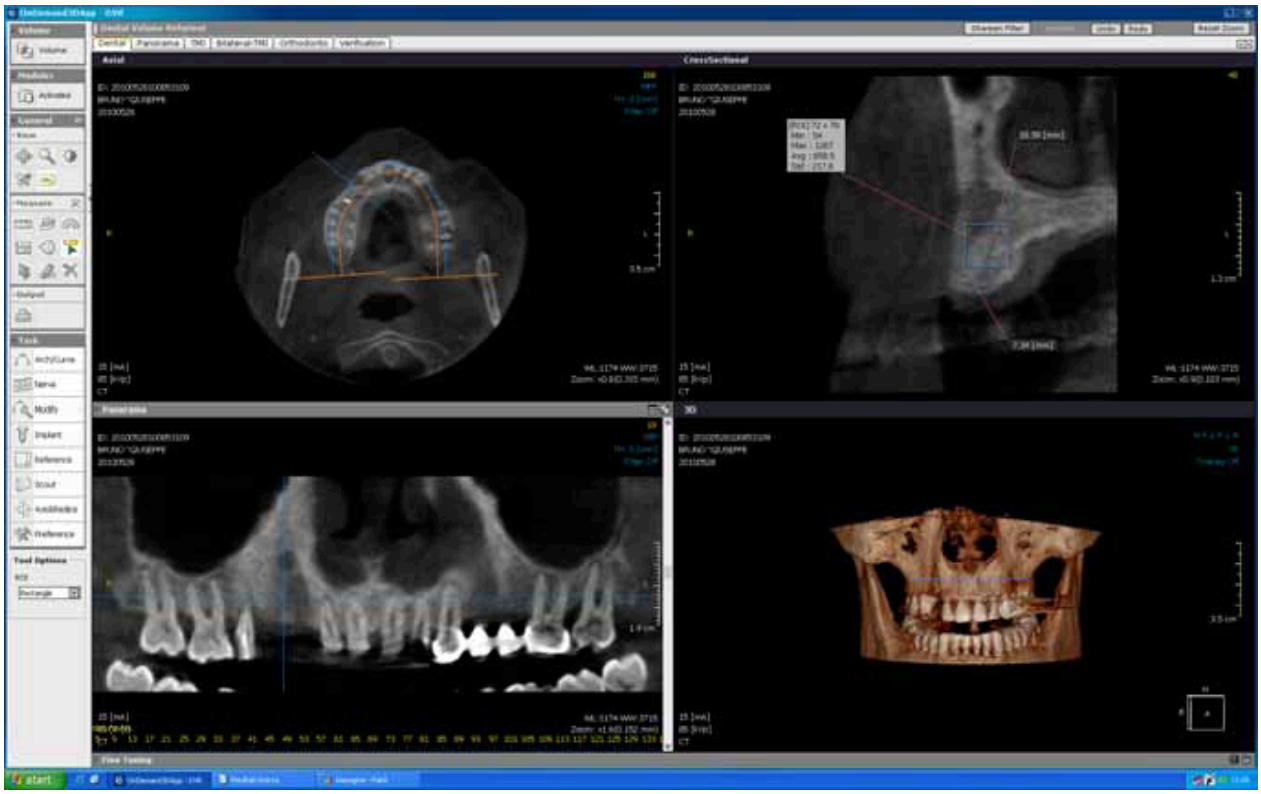

Figure 1: Bone density was measured with a cone beam computed tomography (CBCT), Scanora 3Ds (Soredex, Tuusula, Finland). Area 13, 4 months before surgery.

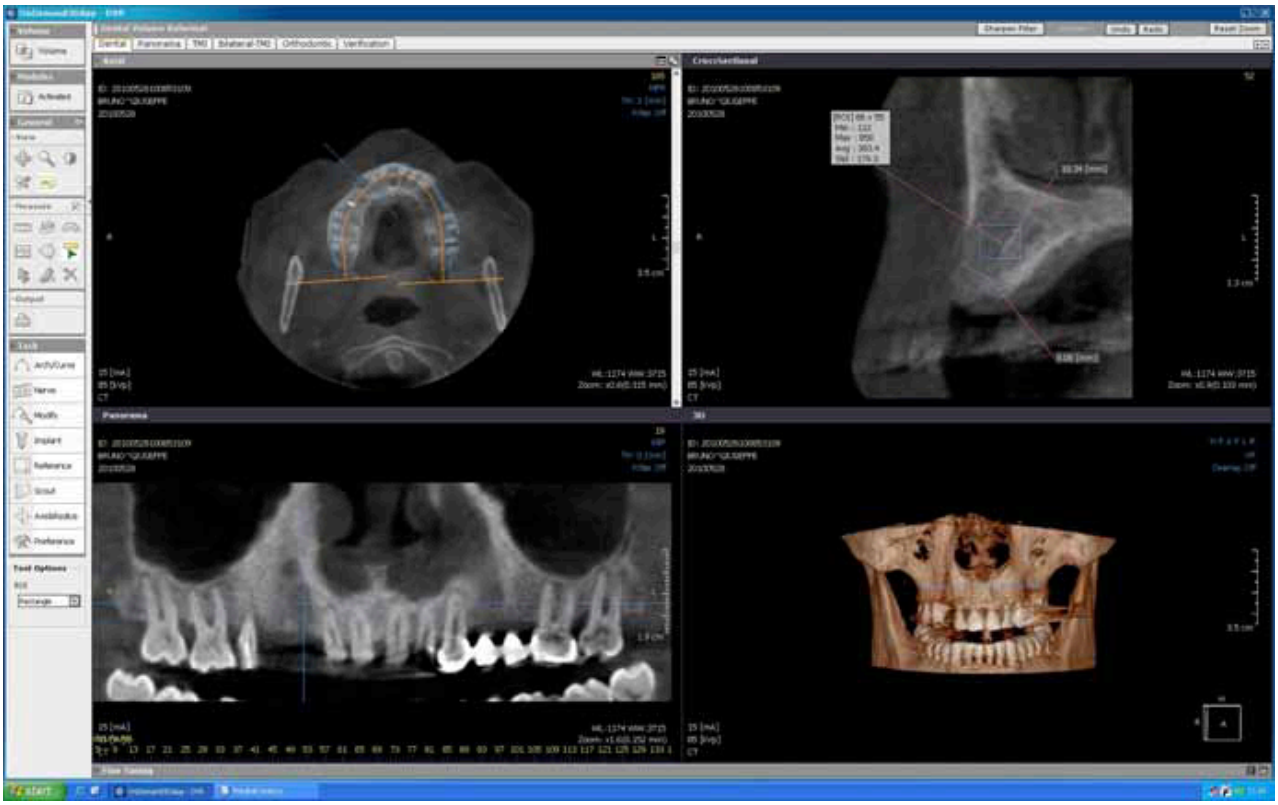

Figure 2: Bone density was measured with a cone beam computed tomography (CBCT), Scanora 3Ds (Soredex, Tuusula, Finland). Area 14, 4 months before surgery.

Figure 3: Bone density was measured with a cone beam computed tomography (CBCT), Scanora 3Ds (Soredex, Tuusula, Finland). Area 13, 4 months after surgery.

Figure 4: Bone density was measured with a cone beam computed tomography (CBCT), Scanora 3Ds (Soredex, Tuusula, Finland). Area 14, 4 months after surgery.

the maxillary incisor region between the central and the lateral incisors, canine region, and the first molar region on a computer, using three-dimensional visualization and measurement software (OnDemand3Dapp–Dental Volume Reformat, Cybermed Inc. Irvine, CA 92618 USA). Subsequently, in each image, a square region of interest (ROI), which was 3.6mm^2 (66 x 55mm) in area, was set in the future implant site: "bone pre-operative", and then was set in the bone around implants of the maxilla. The ROI value was calculated in position of right upper canine and right first upper premolar.

RESULT

Bone density was evaluated by CBCT (Roy's square) 4 months before surgery (time t_0) and 4 months after surgery, at the time of abutment connection (time t_1). About Roy's square in position of right upper canine area, bone density value was in time t_0 on average 393,4 UH (D3, DS 179,3); in time t_1, on average 672,69 UH (D3, DS 80,33). About Roy's square in right first upper premolar area, bone density value was in time t_0 on average 658,5 UH (D3, DS 217,8); in time t_1, on average 626,28 UH (D3, DS 174,30) (Table **1**).

DISCUSSION

The osteotome technique was introduced in oral implantology with the aim of improving primary stability, as well as increasing he success rate in clinical situations of poor quality bone, i.e., the posterior maxilla [14-16]. In theory, osteotomes for bone condensation (tapered osteotomes) provide the possibility of achieving improved primary stability of the implant in

Table 1: Results of Bone Density's Measurements in Area 13 and 14 before and after Surgery

Bone Density		Average (UH)	DS (UH)	Misch's Classification
13 area	T0	393,4	179,3	D3
	T1	672,69	80,33	D3
14 area	T0	658,5	217,8	D3
	T1	626,28	174,30	D3

cancellous bone through radial reinforcement of the bone. Thus, the higher survival rate of oral implants placed with osteotomes for bone condensation has been attributed to an enhancement of the primary stability of the implant due to the lateral osseo compression of the peri-implant trabecular bone [14-17, 19-20].

However, there is a lack of experimental studies that evaluate the course of osseointegration with the osteotome technique compared with conventional implant placement. In literature, it was showed in histological and histomorphometric analysis of implant osseointegration a benefit of the osteotome technique in terms of increased bone to implant contact ratio in the early phase after implant placement [21, 22]. The biological and biomechanical outcome of implants inserted in condensed bone was evaluated in an animal study that demonstrated no significant difference in removal torque testing between implant inserted by the osteotome technique or conventional preparation, but histological analysis demonstrate fractured trabeculae in peri-implant bone when osteotome technique was used [23].

Interestingly, many researchers have also demonstrated the importance of bone microdamage as a direct stimulus for osteoclast activation [24].

Nevertheless, in the posterior maxillae of human cadavers a study showed that with Straumann's tapered osteotomes, the bone condensation is only significant in the fifth apical area but the osteotome technique increases new bone formation and leads to an enhanced osseointegration of dental implants in trabecular bone [25].

The discrepancies observed in animal models may be attributed to differences in loading conditions, healing times and the density of the bone selected for the investigation, i.e., the tibiae condyle of the mini-pig has a more compact bone than the femoral condyle of the rabbit. It is important to mention that the osteotome technique should not be used systematically in all types of bone. It was reported that the use of the osteotome technique in adequate quality bone (types 1 and 2 in Misch's classification) produces more bone resorption than the standard technique [26]. This may be due to the higher forces for bone compression applied in the compact bone. If much force is used to insert implants, the trauma on the bone will cause more bone resorption and osseointegration will take more time [27].

Recently, systematic reviews and meta analysis of clinical studies estimated that after 24–36 months and after 4–5 years, the survival rate of implants placed using the osteotome technique, with and without sinus floor elevation, seems to be similar to that of implants placed using conventional drilling techniques [28-29].

The aim of our study was to evaluate bone density *in vivo* and in human posterior maxilla. The results showed that osteotome technique achieved a significant increase in bone density in area 13 where bone density was 393,4 (lower limit of the range D3), but there was not increase in area 14 where bone density was 658,5 (higher value of the range D3). According to this result and to another our case [30], the authors think that the osteotome technique is the best choice for implant placement in posterior maxilla but only when a low bone density is present (lower limit of the range D3, D4 and D5). Then, in situation of low bone density the simple sharp drills technique can not guarantees a good primary stability and with other bone regenerative technique in posterior maxilla (GBR or bone graft) we can not achieve an immediate implant placement. Reasons for which, when oral implants were placed in the posterior maxilla, the osteotome technique may be chosen as it has two main advantages: (a) the osteotomes instead of sharp drills minimize the surgical complications; (b) implant placement by the osteotome technique give an higher stability.

If the result of our case report can be proved in further human cases, the osteotome technique may become the standard surgical procedure in posterior maxilla with poor bone density (type 3, 4 and 5).

REFERENCES

[1] Adell R, Lekholm U, Rockler B and Branemark PI. A 15 year study of osseo-integrated implants in the treatment of edentulous jaw. Int J Oral Surg 1981; 10: 387-416. http://dx.doi.org/10.1016/S0300-9785(81)80077-4

[2] Albrektsson T, Branemark PI, Hasson HA and Lindstrom J. Titanium implant. Requirements for ensuring a long-lasting direct bone anchorage in man. Acta Orthop Scand 1981; 52: 155-170. http://dx.doi.org/10.3109/17453678108991776

[3] Meredith N. Assessment of implant stability as a prognostic determinant. Int J Prosthodont 1998; 11: 491-501.

[4] Lekholm U and Zarb GA. Patient selection and preparation. In: Branemark PI, Zarb GA, Albrektsson T (ed). Tissue-Integrated Prostheses: Osseointegration in Clinical Dentistry. Chicago: Quintessence Publishing, 1985: 10-110.

[5] Ulm C, Kneissel M, Schedle A, Solar P, Matejka M, Schneider B, *et al*. Characteristic features of trabecular bone in edentulous maxillae. Clin Oral Implants Res 1999; 10: 459-467. http://dx.doi.org/10.1034/j.1600-0501.1999.100604.x

[6] Ulm C and Tepper G. Structure of atrophic alveolar bone. In: Watzek G (ed). Implants in Qualitatively Compromised Bone. London: Quintessence 2004: 29-41.

[7] Jaffin RA and Berman CL. The excessive loss of Branemark fixtures in type IV bone: a 5-year analysis. J Periodontol 1991; 62: 2-4. http://dx.doi.org/10.1902/jop.1991.62.1.2

[8] Jemt T and Lekholm U. Implant treatment in the edentulous maxillae: a 5-year follow up report on patients with different degrees of jaw resorption. Int J Oral Maxillofac Implants 1995; 10: 303-311.

[9] Balshi TJ, Lee HY and Hernandez RE. The use of pterygo maxillary implants in the partially edentulous patient: a preliminary report. Int J Oral Maxillofac Implants 1995; 10: 89-98.

[10] Roccuzzo M and Wilson T. A prospective study evaluating a protocol for 6 weeks' loading of SLA implants in the posterior maxilla: one year results. Clin Oral Implants Res 2002; 13: 502-507. http://dx.doi.org/10.1034/j.1600-0501.2002.130509.x

[11] Bergkvist G, Sahlholm S, Nilner K and Lindh C. Implant supported fixed prostheses in the edentulous maxilla. A 2-year clinical and radiological follow-up of treatment with nonsubmerged ITI implants. Clin Oral Implants Res 2004; 15: 351-359. http://dx.doi.org/10.1111/j.1600-0501.2004.01017.x

[12] Balshi SF, Wolfinger GJ and Balshi TJ. Analysis of 164 titanium oxide-surface implants in completely edentulous arches for fixed prosthesis anchorage using the pterygomaxillary region. Int J Oral Maxillofac Implants 2005; 20: 946-952.

[13] Bahat O. Branemark system implants in the posterior maxilla: clinical study of 660 implants followed for 5 to 12 years. Int J Oral Maxillofac Implants 2000; 15: 646-653.

[14] Summers RB. A new concept in maxillary implant surgery: the osteotome technique. Compendium of Continuing Education in Dentistry 1994a; 15: 152-158.

[15] Summers RB. The osteotome technique: part 2 - the ridge expansion osteotomy (REO) procedure. Compendium of Continuing Education in Dentistry 1994b; 15: 422-426.

[16] Summers RB. The osteotome technique: part 3 - less invasive methods of elevating the sinus floor. Compendium of Continuing Education in Dentistry 1994c; 15: 698-704.

[17] Summers RB. The osteotome technique: part 4 - future site development. Compendium of Continuing Education in Dentistry 1995; 16: 1080-1092.

[18] Rodoni LR, Glauser R, Feloutzis A and Hammerle CH. Implants in the posterior maxilla: a comparative clinical and radiologic study. Int J Oral Maxillofac Implants 2005; 20: 231-237.

[19] Fernandez Valeron J and Fernandez Velazquez J. Placement of screw-type implants in the pterygomaxillary-pyramidal region: surgical procedure and preliminary results. Int J Oral Maxillofac Implants 1997; 12: 814-819.

[20] Nocini PF, Albanese M, Fior A and De Santis D. Implant placement in the maxillary tuberosity: the Summers' technique performed with modified osteotomes. Clin Oral Implants Res 2000; 11: 273-278. http://dx.doi.org/10.1034/j.1600-0501.2000.011003273.x

[21] Misch CE. Density of bone: effect on treatment plans, surgical approach, healing, and progressive loading. Int J Oral Implantol 1990; 6: 23-31.

[22] Nkenke E, Kloss F, Wiltfang J, Schultze-Mosgau S, Radespiel-Troger M, Loos K, *et al.* Histomorphometric and flurescence microscopic analysis of bone remodeling after installation of implants using an osteotome technique. Clin Oral Implants Res 2002; 13: 595. http://dx.doi.org/10.1034/j.1600-0501.2002.130604.x

[23] Buchter A, Kleinheinz J, Weismann HP, Kersken J, Nienkemper M, von Weyhrother H, *et al.* Biological and biomechanical evaluation of bone remodeling and implant stability after using an osteotome technique. Clin Oral Implants Res 2005; 16: 1-8. http://dx.doi.org/10.1111/j.1600-0501.2004.01081.x

[24] Mori S, Harruff R and Burr DB. Microcracks in articular calcified cartilage of human femoral heads. Arch Pathol Lab Med 1993; 117: 196-198.

[25] Blanco J, Suarez J, Novio S, Villaverde G, Ramos I and Segade LA. Histomorphometric assessment in human cadavers of peri-implant bone density in maxillary tuberosity following implant placement using osteotomy and conventional techniques. Clin Oral Implants Res 2008; 19: 505-510. http://dx.doi.org/10.1111/j.1600-0501.2007.01505.x

[26] Strietzel FP, Nowak M, Kuchler I and Friedmann A. Peri-implant alveolar bone loss with respect to bone quality after use of the osteotome technique. Results of a retrospective study. Clin Oral Implants Res 2002; 13: 508-513. http://dx.doi.org/10.1034/j.1600-0501.2002.130510.x

[27] Abrahamsson I, Berglundh T, Linder E, Lang NP and Lindhe J. Early bone formation adjacent to rough and turned endosseous implant surfaces. An experimental study in the dog. Clin Oral Implants Res 2004; 15: 381-392. http://dx.doi.org/10.1111/j.1600-0501.2004.01082.x

[28] Emmerich D, Att W and Stappert C. Sinus floor elevation using osteotomes: a systematic review and meta-analysis. J Periodontol 2005; 76: 1237-1251. http://dx.doi.org/10.1902/jop.2005.76.8.1237

[29] Shalabi MM, Manders P, Mulder J, Jansen JA and Creugers NH. A meta-analysis of clinical studies to estimate the 4.5-year survival rate of implants placed with the osteotome technique. Int J Oral Maxillofac Implants 2007; 22: 110-116.

[30] Santagata M, Guariniello L, D'Andrea A and Tartaro GP. Singletooth replacement in the esthetic zone with ridge expansion osteotomy: a clinical report and radiographic results. J Oral Implantol 2008; 34: 219-22. http://dx.doi.org/10.1563/0.903.1

Received on 27-02-2014 Accepted on 15-03-2014 Published on 31-12-2015

DOI: http://dx.doi.org/10.12974/2311-8695.2015.03.02.3