Retrospective Chart Review to Evaluate the Outcomes of Osseodensification for Implant placement in a Residency Program

Hector M. Carmona, DDS*, Pooja Maney, BDS, MPH, PhD*, Jeanne St. Germain, RDH*,Katherine Carmona BDS*, Liz Mayer RDH*, Thomas E. Lallier, PhD‡

* Department of Periodontology, Center of Excellence in Oral and Craniofacial Biology, School of Dentistry, Louisiana State University Health Science Center, New Orleans, LA.

‡ Department of Cell Biology and Anatomy, Center of Excellence in Oral and Craniofacial Biology, School of Dentistry, Louisiana State University Health Science Center, New Orleans, LA.

Hector M. Carmona, 1100 Florida Avenue, New Orleans Louisiana 70119

Phone: (504) 941-8390

Fax: (504) 941-8391

Word count: 3966

Figures: 7 Tables, 1 Figure

References: 32

Short Title: Outcomes of Osseodensification for Implant placement in a Residency Program

Summary: The use of Osseodensification Drills was found to have no significant difference to conventional drills in implant survival.

Abstract:

Purpose: To examine the survival rates of implants placed using osseodensification(OSD) burs (Densah®) in a periodontal residency program.

Materials & Methods: A retrospective chart review was conducted to evaluate maxillary implants placed using either OSD or conventional implant drills. Furthermore, this study examined the effect on survival rate of OSD with simultaneous sinus elevation. Examined parameters were Implant brand, implant length, Insertion torque value (ITV), Implant stability quotient (ISQ) at placement and uncovery, CT Hounsfield units, age of patient, and the use of SSRI and PPI's.

Results: A total of 290 implants in 162 patients, with 146 implants in the OSD group and 144 in the control group, were analyzed. The overall survival rate was 98% for the control group and 95% for the OSD group. Patient age, implant brand, implant length, and SSRI or PPI use had no significant effect on implant survival.. Within the OSD group, implant survival rates were very similar for with and without sinus elevation (95% and 94% respectively).However, within the sinus elevation group, implants where additional graft material was used, showed a survival rate of 90% vs implants where no graft material was used had a survival rate of 100% and this difference was statistically significant.

Conclusion: Within the limitations of this study, the use of OSD for implant placement and indirect sinus elevations in a residency program is a viable option and yielded comparable results to conventional drilling protocols. The indirect sinus elevation is technique sensitive and care should be taken with the use of additional graft material and increasing amount of elevation.

Key Words: dental implants, osseodensification, sinus elevation,

Introduction:

Dental implants have become a viable and successful treatment option for the replacement of missing teeth in both partially and fully edentulous patients. Oral health surveys conducted in the United States show that there are a large number of individuals with compromised dentitions whom endosseous dental implants may be indicated (1). The success of implants primarily depends upon their firm anchorage to the surrounding bone, referred to as osseointegration (2). Osseointegration has been defined as a direct connection between bone and the surface of a load-bearing implant at the microscopic level (2). Studies have shown that the placement of dental implants is a predictable procedure, with most studies showing a multi-year success rate of greater than 90% for fully edentulous patients(3-6).

The quality and density of bone varies in the oral cavity and has been classified as type 1: large homogenous cortical/compact bone, Type 2: thick layer of compact bone surrounding dense trabecular bone, Type 3: thin cortical layer surrounding dense trabecular bone and Type 4: thin cortical layer surrounding a core of low-density trabecular bone (7). A recent study showed that implant failure rates in these different bone types were 3.38%, 3.13%, 4.27%, and 8.06% respectively, indicating that the softer type 4 bone has the highest failure rate (8). Cone beam computed tomography (CBCT) imaging has been used to estimate bone density. In a recent study, a significant positive correlation was found between the thickness of the cortical bone and the insertion torque values (ITVs) or the implant stability quotient (ISQ) values in different implants(9). ITV and ISQ are frequently used clinical measures of implant stability.

Conventional drilling protocols for implant placement include osteotomy preparation using drills that cut and remove bone in order to create a cylindrical osteotomy that will receive an implant fixture (10). These drills consist of a specified length and diameter shank, with a pointed chisel end and cutting lips that extend to the outer diameter of the drill. The shank is fitted with spiral guides and flutes that have a positive angle called the rake that remove debris

(bone) from the osteotomy. Most efficiently designed drills will have two to three flutes with cutting edges that have a 25-35 degree rake angle(11).

A new surgical technique termed osseodensification (OSD) was introduced to be able to increase the percent bone volume (% BV) around dental implants inserted in low-density bone, which may play a role in enhancing implant stability (12). OSD is a novel biomechanical bone preparation to place a dental implant, using specially designed burs (Densah® burs) which are rotated in reverse at 800 to 1500 rpm. Standard traditional implant drills remove and excavate bone during implant site preparation, whereas, the newer OSD burs (Densah®) allow bone preservation and condensation through compaction autografting during osteotomy preparation thereby increasing the peri-implant bone density (% BV), and the implant mechanical stability(13). Huwais and Meyer showed that OSD significantly increased insertion and removal torques compared to standard drilling or extraction drilling (14). These OSD burs are designed to have many lands with a large negative rake angle, which work as non-cutting edges to increase the density of the bone as they expand an osteotomy (15).

OSD burs are particularly useful to in the posterior maxilla where the bone quality is poorest. Following tooth loss in the posterior maxilla, significant pneumatization of the sinus and atrophy of the remaining alveolar ridge frequently occurs. In order to place permanent fixtures in these areas, augmentation of the sinus is needed to create sufficient vertical bone volume, further complicating treatment (7). Undersized implant site preparation (20,21) and the use of osteotomes to condense bone(22,23) are surgical techniques previously proposed to increase primary implant stability in poor density bone. Osteotomy under-preparation may increase implant primary stability, but a greater amount of necrotic dieback and interfacial remodeling may occur at the implant surface, potentially decreasing the implant secondary stability during healing(24).

Traditionally, two techniques have been used for vertical sinus augmentation, namely, the direct sinus elevation procedure using a lateral window approach and the indirect sinus

elevation procedure using a crestal approach (Summer's technique) (25). The lateral window technique has been shown to have highly predictable results and long-term implant stability(26). But this procedure is invasive and is associated with significant drawbacks such as membrane perforation, delayed healing time, and a higher risk of postsurgical infections(27). The Summer's osteotome technique has been shown to be less invasive with high predictability in sinus elevations up to 4 to 5 mm (28). This procedure is also associated with drawbacks such as use of poorly controlled forces to elevate the sinus floor, membrane perforation, and benign paroxysmal positional vertigo(29). The introduction of OSD burs has helped overcome some of the drawbacks of the Summer's technique.

This study aimed to evaluate the outcomes of osseodensification on primary implant stability, and survival in a periodontal residency program. Other secondary factors were also examined such as surgeon year of implant training, medical history, performance of crestal sinus elevation, addition of graft material in the sinus cavity and initial bone density estimates through CBCT imaging. By examining the effects of osseodensification we hope to show the success/complications presented using the Densah® protocol.

Materials and Methods:

Approval was obtained from the Louisiana State University Institutional Review Board – New Orleans (IRB #20-889). Electronic records of all edentulous and partially edentulous patients, who had been rehabilitated with dental implants between November 1, 2017 and March 13, 2020 in the department of periodontics postgraduate residency program at Louisiana State University School of Dentistry (LSUSD), were screened.

Experimental Group (OSD):

Inclusion criteria:

- Patients 18 years or older

- Edentulous or partially edentulous patients who had received implant placement in the department of periodontics using OD burs.
- Patients that had received trans crestal indirect sinus elevations at the time of implant placement using OD burs.

Exclusion criteria:

- Patients with ASA 3 or above status
- Patients with a previously failed implant at the site being examined.

Control Group: The same inclusion and exclusion criteria were used, except that implants were placed following the use of traditional drills to prepare the osteotomy. Since 2017, transcrestal sinus lifts in the postgraduate periodontal training program have been performed using OSD burs, there were no patients who received indirect sinus lifts in the control group.

The following patient level information was obtained:

- Age
- Smoking status
    - Current- defined as actively smoking at the time of implant placement
    - Former- Patient has a history of smoking with at least 1 year since quitting.
    - Non- Patient has no history of smoking
- Diabetes with A1c (if reported)
- Bisphosphonate use
- Proton Pump Inhibitor (PPI) use
- Hypertension medication use
- Selective-Serotonin Reuptake inhibitor (SSRI) use

The following implant level information was obtained:

- Site

- Indirect sinus lift
- Additional graft material placed in sinus
- Insertion torque values (ITV)
- Implant Stability Quotient (ISQ) at placement (and uncovery if applicable)
- Implant system
- Implant length

Implant Survival: Implant survival was defined as an implant remaining in situ without any biological complications and supporting a functional prosthesis when applicable(16,17,18).

Implant Failure: Implant failure was defined as loss of the implant or conditions that necessitated removal of the implant.

Statistical Analysis:

The influence of each of the patient level and implant level parameters on implant survival rate was analyzed. Average values of ITV, ISQ, and CBCT Hounsfield units (HU) were obtained.

Results:

Patient Demographics

The average age of participants was 58 y/o and 59 y/o for the control and OSD group respectively, which were very similar. The distribution of subjects in the OSD and control groups according to the demographics examined are presented in table 2. These parameters included gender, smoking status, diabetic status, osteoporosis status, bisphosphonate use, SSRI use, PPI use and hypertension medication use. Overall, all patient level parameters were equally represented in both groups.

Cumulative Survival rates

A total of 290 implants in 162 patients were analyzed, with 146 implants in the OSD group and 144 in the control group (Table 1A). The survival rate was 98.6% and 94.6% for the

control and OSD groups respectively with no significant difference between them. The different implant systems used (Table 1B) 147 (50.7%) implants being Zimmer with survival rates of 100% and 94.6% for the control and OSD groups respectively with no significant difference among implant brand and survival rate. 221 of the 290 implants placed were 10mm in length with a range from 8mm-16mm and no significant effect on survival rate was shown.

The overall survival rates for the different patient demographics (table 2) show a range of survival rates from 89 – 100%, the exception being bisphosphonate use in the control group which shows a survival rate of 80% but only 5 patients were represented in this group. The overall data showed no significant effect on implant survival for the patient demographics, medical history, smoking status, and grafting at time of implant placement.

Implant Stability Measures and CBCT HU Values

ITV values were reported for a total of 115 implants in the control group and 95 implants in the OSD group, with average values of 34 for each group respectively and showed no significant difference. ISQ values at implant uncovery were reported for 100 implants in the control group and 93 in the OSD group with averages of 70 and 71 respectively, ISQ at uncovery was reported for 62 implants in the control and 78 implants in the OSD group. No significant differences were found between the OSD group and control groups (table 3A, 3B). The CBCT HU values were also reported (table 3b) for the groups, however, due to the large standard deviation, there were no significant differences found between these groups. Overall, none of the measures for implant stability or CBCT HU had an impact on implant survival.

Implant Surgical Site

A total of 43 implants were placed in the anterior maxilla 28 in the control group and 15 in the OSD group with survival rates of 96% and 93% respectively, which were not significantly different. 225 implants were placed in the posterior maxilla with 107 in the control group and 118 in the OSD group and survival rates of 99% and 94% respectively, with no significant differences. Mandibular implants were only included if they were being placed at the same

surgical appointment as implants being analyzed in this study. A total of 22 mandibular implants were included, with 9 in the control group and 13 in the OSD group with survival rates of 100% for both with no significant differences. [MP1]

Osseodensification and Indirect Sinus Elevations

Sinus elevations within the OSD group made up just over 50% of the implants and had a 95% survival rate, compared to implants within the group that had no sinus elevation at 94%. No significant difference in implant survival rates was found with and without sinus elevation. Within the sinus elevation group there was a statistically significant difference in implant survival rate if additional graft material was added to the sinus elevation (Table 4). The addition of graft material with sinus elevation had a survival rate of 90% compared to 100% if no additional graft was added. Furthermore, the amount of sinus elevation performed also lowered the survival rate (Figure 1) with decreasing survival with each mm increment in elevation with 100% for a 1mm elevation, down to 90% for a 4mm elevation. Three implants were outliers, with 100% success rate with an elevation of 5mm (2) and 7mm (1).

Discussion:

This study demonstrated that for most parameters examined, there was no statistical difference in the survival rates of implant placed using OSD or traditional drilling protocols in a periodontal residency program. Achieving primary stability is very important for establishing osseointegration. Lahen B et al., in their study examined the effect of OSD on the primary stability and early osseointegration of implants and showed that OSD significantly increased insertion torque values(30). This was not shown in this study and the values were comparable to traditional drilling techniques; Huwais et al., showed that although penetration forces and torque are slightly increased during OSD they were clinically similar to conventional drilling(14).

Traditionally the use of SSRI's and PPI's has been associated with a higher implant failure rate; Chappuis et al., showed an odds ratio of failure of 2.02 and 2.92 for PPI's and

SSRI's respectively. These findings were not reflected in our study. However, this could be due to only a limited number of patients in these groups, with 18% and 8% of patients who were taking SSRI's and PPI's respectively.

Overall, implant survival within the OSD group was not significantly different between implants with and without indirect sinus lifts. However, when there was an increase in the amount of sinus lift and when there was use of additional grafting material a significant decrease in survival rates was found. Huwais et al. reported a survival rate of 97% following sinus lifts of up to 7mm (32)., While the overall survival rate in our study was similar at 95%, we saw a significantly decreased survival rate with sinus elevations above 3mm (92%)and also with the addition of graft material (90%).

Osseodensification is a fairly recently adopted and a technique sensitive procedure, besides, the protocol has been changed since its inception of the technology. Therefore a limitation of this study is that it was conducted in a periodontal training program, so clinician experience of the implant surgeons was limited.

Ultimately there is a need for more long-term research studies to examine the survival of implants placed with simultaneous indirect sinus elevations, including a comparison of implants placed using OSD versus the Summer's osteotome technique.

Conclusion:

Within the limitations of this study the use of OSD for implant placement in less dense bone and indirect sinus lifts in a residency program is a viable option and yielded comparable results to conventional drilling protocols. The indirect sinus elevation is technique sensitive and care should be taken with the use of additional graft material and increasing amount of elevation.

Footnotes

* Department of Periodontology, Center of Excellence in Oral and Craniofacial Biology, School of Dentistry, Louisiana State University Health Science Center, New Orleans, LA.

† Department of Cell Biology and Anatomy, Center of Excellence in Oral and Craniofacial Biology, School of Dentistry, Louisiana State University Health Science Center, New Orleans, LA.

References:

1. Harvey C, Kelly JE. Decayed, missing and filled teeth among persons 1-74 years, United States. Vital and health statistics. *National Center for Health Statistics. US Department of Health and Human Services* 1981; Pub No 81-1673, series 11, No 223.
2. Bränemark PI. Introduction to osseointegration. In: Bränemark PI, Zarb G, Albrektsson T, eds. *Tissue Integrated Prostheses: Osseointegration in Clinical Dentistry.* Chicago: Quintessence; 1995;11-76.
3. Spiekermann H, Jansen VK, Richter EJ. A 10-year follow-up study of IMZ and TPS implants in the edentuous mandible using bar-retained overdentures. *Int J Oral Maxillofac Implants* 1995;10:231-243.
4. Albrektsson T et al: The long term efficacy of currently used dental implants: A review and proposed criteria of success. Int J Oral Max Implants 1:11-26, 1986
5. Misch CE, Perel ML, Wang HL, et al. Implant success, survival, and failure: the International Congress of Oral Implantologists (ICOI) Pisa Consensus Conference. Implant Dent. 2008 Mar;17(1):5-15.
6. Moraschini V, Poubel LA, Ferreira VF, Barboza Edos S. Evaluation of survival and success rates of dental implants reported in longitudinal studies with a follow-up period of at least 10 years: a systematic review. Int J Oral Maxillofac Surg. 2015 Mar;44(3):377-88
7. J Lekholm U, Zarb GA. Patient selection and preparation. In: Brånemark PI, Zarb GA, Albrektsson T. Tissue-Integrated Prostheses: Osseointegration in Clinical Dentistry. Chicago: Quintessence Publishing Company, 1985:199–209.

8. Chrcanovic BR, Albrektsson T, Wennerberg A. Bone Quality and Quantity and Dental Implant Failure: A Systematic Review and Meta-analysis. Int J Prosthodont. 2017 May/June;30(3):219–237.
9. Wada M et al. The relationship between the bone characters obtained by CBCT and primary stability of the implants. Int J Implant Dent. 2015 Dec;1(1):3.
10. Bertollo N, Walsh WR. Drilling of bone: Practicality, limitations and complications associated with surgical drill bits. In: Klika V (ed). Biomechanics in Application. InTech, 2011:45–82.
11. Jackson CJ, Ghosh SK. On the evolution of drill-bit shapes. J Mechanical Working Tech 1989;18:231–267.
12. Trisi P, Beradini M, Falco A, Vulpiani P. New Osseodensification Implant Site Preparation Method to Increase Bone Density in Low-Density Bone: *In Vivo* Evaluation in Sheep. Implant Dent. 2016 Feb; 25(1): 24–31.
13. Kanathila H, Pangi A, An insight into the concept of osseodensification-enhancing the implant stability and success. July 2018. Journal of Clinical and Diagnostic Research 12(7):ZE01-ZE03.
14. J Huwais S, Meyer EG. A Novel Osseous Densification Approach in Implant Osteotomy Preparation to Increase Biomechanical Primary Stability, Bone Mineral Density, and Bone-to-Implant Contact. Int J Oral Maxillofac Implants 2017;32:27–36.
15. Huwais S. Fluted osteotome and surgical method for use. US2013/0004918. US Patent Application, 3 January 2013.
16. G Papaspyridakos, P., Chen, C. J., Chuang, S. K., Weber, H. P., & Gallucci, G. O. (2012). A systematic review of biologic and technical complications with fixed implant rehabilitations for edentulous patients. The International Journal of Oral and Maxillofacial Implants, 27, 102–110.

17. Papaspyridakos, P., Chen, C. J., Singh, M., Weber, H. P., & Gallucci, G. O. (2012). Success criteria in implant dentistry: A systematic review. Journal of Dental Research, 91, 242–248.
18. Heitz-Mayfield, L. J., Needleman, I., Salvi, G. E., & Pjetursson, B. E. (2014). Consensus statements and clinical recommendations for prevention and management of biologic and technical implant complications. The International Journal of Oral and Maxillofacial Implants, 29, 346–350
19. Wittneben, J. G., Buser, D., Salvi, G. E., Bürgin, W., Hicklin, S., & Brägger, U. (2014). Complication and failure rates with implant-supported fixed dental prostheses and single crowns: A 10-year retrospective study. Clinical Implant
20. Alghamdi H, Anand PS, Anil S. Undersized implant site preparation to enhance primary implant stability in poor bone density: A prospective clinical study. J Oral Maxillofac Surg. 2011;69:506–512.
21. Degidi M, Daprile G, Piattelli A. Influence of underpreparation on primary stability of implants inserted in poor quality bone sites: An in vitro study. J Oral Max- illofac Surg. 2015;73:1084–1088.
22. Summers RB. A new concept in maxillary implant surgery: The osteotome technique. Compendium. 1994;15:152, 154–156, 158 passim; quiz 162.
23. Boustany CM, Reed H, Cunningham G, et al. Effect of a modified stepped osteotomy on the primary stability of dental implants in low-density bone: A cadaver study. Int J Oral Maxillofac Im- plants. 2015;30:48–55.
24. Campos FE, Gomes JB, Marin C, et al. Effect of drilling dimension on implant placement torque and early osseointegration stages: An experimental study in dogs. J Oral Maxillofac Surg 2012;70:e43-e50.
25. Tatum H Jr. Maxillary and sinus implant reconstructions. Dent Clin North Am 1986;30:207-229.

26. Wallace SS, Froum SJ. Effect of maxillary sinus augmentation on the survival of endosseous dental implants. A systematic review. Ann Periodontol 2003;8:328-343.
27. Wallace SS, Mazor Z, Froum SJ, Cho SC, Tarnow DP. Schneiderian membrane perforation rate during sinus elevation using piezosur- gery: Clinical results of 100 consecutive cases. Int J Periodontics Restorative Dent 2007;27:413-419.
28. Kfir E, Goldstein M, Yerushalmi I, et al. Minimally invasive antral membrane balloon elevation - results of a multicenter registry. Clin Implant Dent Relat Res 2009;11(suppl 1):e83–e91.
29. Toffler M, Rosen P. Complications with transcrestal sinus floor elevation: Etiology, prevention, and treatment. In: Froum S (ed). Dental Implant Complications: Etiology, Prevention, and Treatment Hoboken, New Jersey: Wiley, 2015.
30. Lahens B, Neiva R, Tovar N, Alifarag AM, Jimbo R, Bonfante EA, et al. Biomechanical and histologic basis of osseodensification drilling for endosteal implant placement in low density bone. An experimental study in sheep. J Mech Behav Biomed Mater. 2016;63:56-65.
31. J Chappuis V, Avila-Ortiz G, Araújo MG, Monje A. Medication-related dental implant failure: Systematic review and meta-analysis. Clin Oral Implants Res. 2018;29 Suppl
32. Huwais S, Mazor Z, Ioannou AL, Gluckman H, Neiva R. A Multicenter Retrospective Clinical Study with Up-to-5-Year Follow-up Utilizing a Method that Enhances Bone Density and Allows for Transcrestal Sinus Augmentation Through Compaction Grafting. Int J Oral Maxillofac Implants. 2018 Nov/Dec; 33(6):1305-1311.

Figure Legends

Table1A: Total number of patients in each group then the number of patients that were included in both groups to yield total patients. Number of implants in each group and total for the study.

Table 1B: The number of each implant analyzed per brand and study group with subsequent survival and failure rates.

Table1C: Implant length survival rates with number of cases in each per study group.

Table2: Patient demographics survival rates with corresponding number of cases broken down per study group.

Table 3: Shows the average values without SD for ITC, ISQ at placement and uncovery, and CT Hounsfield units first in both study group totals. Then the averages are broken down per study group for all the implants that survived and all the implants that failed.

Table 4: Survival rates within the OSD group only with corresponding number of cases for total Sinus lifts and total non sinus lifts. Survival rates and cases for total 1-2mm sinus lift and 3-4mm sinus lift. Survival rates and cases for total sinus lifts with no additional graft and sinus lift with additional graft material. Survival rates and cases within the additional graft group for 1-2mm and 3-4mm sinus lifts.

Figure 1: Graphical representation of survival rates for total sinus lift cases per millimeter increments with the number of cases in each represented on the graph point. 1mm (17 cases) 100% survival rate, 2mm (18 cases) 94% survival rate, 3mm (25 cases) 96% survival rate, 4mm (11 cases) 90% survival rate.

Table 1A

	Control	OSD	Duplicates	Total
Total Patients	92	83	13	162
Total Implants	144	146	n/a	290

Table 1B

Type of Implant OSD	#	Failures	Survival %	Failure %
Astra EV	1		100.00	
Nobel	38	2	94.74	5.26
Strauman	33	2	93.94	6.06
Zimmer	74	4	94.59	5.41
Total	146	8		
Type of Implant Control	#	Failures	Survival %	Failure %
Astra	6	1	83.33	16.67
Nobel	48	1	97.92	2.08
Zimmer	73		100.00	
Strauman	17		100.00	
	144	2		

Table 1C

Implant Length (mm)	Control	OSD
8	100% (9)	100% (7)
9	100% (2)	100% (1)
10	100% (101)	94% (120)
11	0% (1)	n/a
11.5	100% (18)	89% (9)
12	100% (3)	100% (5)
13	92% (8)	100% (2)
16	100% (2)	100% (2)

Table 2

Demographics	Control	OSD
Male	98% (58)	90% (49)
Female	98% (86)	96% (97)
Current Smokers	100% (18)	96% (24)
Former Smokers	97% (33)	89% (28)
Non	98% (93)	96% (94)
Diabetic	100% (17)	93% (14)
Non-Diabetic	98% (127)	95% (132)
Osteoporosis	100% (10)	100% (12)
non-Osteoporosis	98% (134)	94% (134)
Bisphosphonates	80% (5)	100% (2)
non-Bisphosphanate	99% (139)	94% (144)
SSRI	96% (27)	96% (25)
Non-SSRI	99% (117)	94% (121)
PPI	100% (11)	100% (13)
Non-PPI	98% (133)	94% (133)
Hypertension Meds	98% (57)	97% (66)
Non-Hypertension	99% (87)	94% (80)
Bone Graft At time of placement	97% (35)	92% (26)
Non-Bone Graft	99% (109)	96% (120)

Table 3a

Control	Average	Median	STD	Average of Success	Median of Success	STD	Average of failure	Median of Failure	STD
Age	58.4236111	59	12.28768208	58.35915493	59	12.36004863	63	63	2.8284
ITV	34.0789474	35	4.606929634	33.94736842	35	4.505340205	45	45	n/a
ISQ at Placemen	70.4444444	72.5	9.876763312	70.43877551	72.75	9.927382029	71	71	n/a
ISQ at UNC	75.5322581	75	7.437648452	75.91803279	75	6.845424462	52	52	n/a
CT HU	484.482014	426	280.3430443	482.1605839	422	281.2763774	643.5	643.5	185.97
Implant Length	10.3472222	10	1.235089784	10.32394366	10	1.222132166	12	12	1.4142
mplant Diamete	3.94513889	3.7	0.475972301	3.945070423	3.7	0.477519814	3.95	3.95	0.495
Year of Training	2.6875	3	0.479929336	2.690140845	3	0.479111154	2.5	2.5	0.7071

Table 3b

OSD	Average	Median	STD	Average of Success	Median of Success	STD	Average of failure	Median of Failure	STD
Age	59.114094	59	12.34959968	59.58695652	61	12.26455832	58.625	59	14.638
ITV	34.0105263	35	6.15317724	34.11235955	35	5.893829983	32.85714286	35	9.0633
ISQ at Placement	70.9202128	72	6.895262201	71.09090909	72	6.965244364	68.8	70	6.5822
ISQ at UNC	73.2727273	72.5	6.185480375	73.31168831	72.5	6.205917677	75	75	n/a
CT HU	302.895833	278	197.3170293	301.4044118	278	192.3787306	328.25	252	284.31
Implant Length	10.1815068	10	1.032038721	10.18115942	10	1.054953607	10.1875	10	0.5303
mplant Diamete	4.2130137	4.1	0.515051213	4.212318841	4.1	0.51267908	4.225	4.4	0.5922
Year of Training	2.78082192	3	0.415113623	2.775362319	3	0.418863878	2.875	3	n/a

Table 4

OSD Group	Survival Rate
Sinus Lift (total)	95% (74)
Non SL	94% (72)
Sinus Lift 1-2 mm	97% (35)
Sinus Lift 3-4mm	92% (36)
Sinus Lift no graft	100% (30)
Sinus Lift with graft	90% (44)
Sinus Lift 1-2mm with graft in sinus	92% (12)
Sinus Lift 3-4mm with graft in sinus	90% (29)

Figure 1