

**“Randomized Controlled Trial Comparing Short Dental
Implants Versus Longer Dental Implants Combined with
Bone-Added Osteotome Sinus Floor Elevation.
Clinical, Radiographic and Patient-Recorded Outcomes”**

Thesis

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Dedication

To My Mother and Father, to whom I am eternally grateful. None of this would have been possible without your unconditional love, support, and guidance.

To both My Brothers Assem and Abed, who always believed in me, thank you for your continuous help and encouragement.

*“I don't care how poor a man is;
if he has **Family**, he's rich.” - Dan Wilcox*

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List of Abbreviations:

BAOSFE: Bone Added Osteotome Sinus Floor Elevation.

BIC: Bone Implant Contact.

BPPV: Benign Paroxysmal Positional Vertigo.

ICOI: International Congress of Oral Implantologists

ISQ: Implant Stability Quotient.

MBL: Marginal Bone Loss.

OHIP: Oral Health Impact Profile.

OSFE: Osteotome Sinus Floor Elevation.

RFA: Resonance Frequency Analysis.

SFE: Sinus Floor Elevation

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Review of Literature:

Nowadays, Implants are considered predictable treatment tools for rehabilitating patients with missing teeth.⁽¹⁾ Furthermore, most of the published long-term studies reported survival rates exceeding 95%.⁽²⁾⁽³⁾⁽⁴⁾

The posterior maxillary arch poses a significant challenge for dental rehabilitation using implants. The ideal implant placement is complicated by insufficient residual ridge dimensions.⁽⁵⁾ The extraction of maxillary posterior teeth results in a rapid rate of alveolar bone resorption both horizontally and vertically. This decrease in alveolar ridge height and width is due to lack of the minimal essential strain transmitted through periodontal ligament fibers. Following the extraction of maxillary molars, the increased osteoclastic activity of the Schneiderian membrane causes pneumatization of the maxillary sinus.⁽⁶⁾ Moreover, according to Lekholm and Zarb (1985), the posterior region of the maxilla is classified as type IV denoting an area of low or poor bone quality.⁽⁷⁾

Collectively, all these factors can impose a great clinical challenge for the dentist to achieve successful satisfying results after rehabilitation of this area using dental implants.⁽⁸⁾ To overcome these limitations, several adjunctive procedures have been proposed, such as guided bone regeneration,⁽⁹⁾ block graft,⁽¹⁰⁾ distraction osteogenesis,⁽¹¹⁾ and sinus floor elevation.⁽¹²⁾ These augmentation techniques can successfully allow implant placement by increasing the residual alveolar ridge height and width.⁽⁹⁾ Nevertheless, The success of these techniques is highly dependent on the expertise of the surgeon. Patient acceptance is greatly affected by donor site morbidity, as well as treatment time and expenses.⁽¹³⁾⁽¹⁴⁾

A review of clinical publications was conducted to evaluate the success rates of these techniques and the survival rates of implants placed thereupon. The analysis performed by Chiapasco et al revealed success rates of 60% to 100% for guided bone regeneration, 92% to 100% for onlay bone grafts, and 96.7% to 100% for distraction osteogenesis. Moreover, the implants survival rates ranged from 92% to 100% with guided bone regeneration, 60% to 100% with onlay bone grafts, 90.4% to 100% with distraction osteogenesis.⁽⁵⁾

Reports supporting treatment alternatives have been presented by different authors. These reports aimed at overcoming several demerits of the previously reported techniques. The merits of these reports focused mainly on avoiding vital structures (namely the maxillary sinus in the posterior maxilla), decreasing surgical morbidity, and improving patient satisfaction.⁽¹⁴⁾⁽¹⁵⁾⁽¹⁶⁾⁽¹⁷⁾

Zygomatic,⁽¹⁸⁾ short,⁽¹⁵⁾ or tilted implants⁽¹⁶⁾⁽¹⁹⁾ are viable treatment alternatives when considering rehabilitation of the posterior maxilla. These techniques drive their importance from the fact that they abate the need for Schneiderian membrane repositioning. The techniques have been associated with reports of favorable long-term outcomes.

Regarding the sinus floor elevation procedure, Tatum modified the Caldwell-Luc procedure and proposed the sinus lift with lateral approach in 1977. Soon after, it was published by Boyne and James in 1980.⁽²⁰⁾⁽²¹⁾ Later on by 1986, Tatum described the elevation of the sinus floor through an alveolar crest approach. This involved the use of socket formers to prepare the implant site and elevate the sinus floor with immediate implant placement.⁽²²⁾

This transalveolar technique was modified in 1994 by Summers. The author advocated tapered osteotomes of increasing diameters with concave tips to prepare the osteotomy site, up-fracture the floor of maxillary sinus, and

elevate its membrane. The osteotome sinus floor elevation (OSFE) is considered a less invasive technique, reducing chair time and postoperative morbidity.⁽²³⁾

In a step to improve this method, Summers described the bone-added osteotome sinus floor elevation technique (BAOSFE) where he added bone mixture in the osteotomy to act as a cushion; simplifying the sinus floor elevation and reducing the rate of sinus membrane perforation.⁽²⁴⁾ Although this technique is less invasive than the lateral approach sinus floor elevation, This does not mean that it is a complication-free procedure.

Such associated uneventful situations could be classified into Intra or Post-operative complications. One of the main drawbacks of the OSFE technique is the impossibility to visualize the sinus floor. Being performed blindly, there is always an uncertainty of a possible perforation of the Schneiderian membrane.⁽²¹⁾⁽²²⁾ It has been reported that these perforations could be encountered with an incidence range of 4-25% in comparison to 25–44% for external sinus lifting procedures.⁽²⁵⁾⁽²⁶⁾ Even though it may not always be determined with the Valsalva maneuver, a sinus membrane perforation could be discovered later by the development of sinusitis, epistaxis, exfoliation of graft particles from the nose, or a patent oral-antral communication.⁽²⁷⁾

As well, lack of primary implant stability is one of the attributed intra-operative complications. It may be related to insufficient pre-operative bone height/width, poor bone quality, or improper site preparation with the osteotomes.⁽²⁸⁾ Regardless its uncommon occurrence, the use of excessive force during implant insertion could lead to its accidental displacement into the sinus cavity. This also may occur due to untreated membrane perforation, or decreased bone quality.⁽²⁹⁾

On the other hand, surgical site infection is reported as the most common postoperative complication.⁽³⁰⁾ In addition to hemorrhage, nasal bleeding, blocked nose, and hematomas, the incidence of OSFE-induced benign paroxysmal positional vertigo (BPPV) has been reported to be less than 3%. This is a self-limiting condition characterized by short, repeated, brief periods of vertigo that are triggered by certain head movements. Even though the symptoms involved subside or disappear within 6 months of onset, it may be sufficiently severe to remarkably affect the patient's quality of life. It is advised to perform gentle hammering with a safe head position in order to prevent this complication.⁽³¹⁾⁽³²⁾

As a consequence of abovementioned complications, implant failures could be the unfavorable result.⁽³²⁾ According to the reported failures, implant losses associated with OSFE usually occur before loading.⁽³³⁾ Almost 10–20% increase in implant failures has been shown to be associated with implant placement in 4 mm or less presurgical sub-antral bone.⁽³⁴⁾ Usually, the decision to apply either the lateral approach or the crestal approach sinus lift technique depends on the available residual bone height. A residual bone height of approximately 5mm or less warrants a lateral approach rather than the crestal approach.⁽³⁵⁾

Autogenous bone has osteogenic potential along with both osteoinductivity and osteoconductivity with no risk of graft rejection. Knowing this fact, it has been recommended as the gold standard for grafting during sinus augmentation procedures. Despite that, other alternative materials have been developed in order to overcome autogenous bone disadvantages, such as its limited volume and availability, unpredictability, and donor site morbidity.⁽³⁶⁾

These alternatives could be categorized into three groups: (1) Allogenic; same species but from another individual, (2) Xenogenic; from different species, and (3) Alloplastic; synthetic bone substitute.⁽³⁶⁾⁽³⁷⁾ An-organic bovine bone was found to have an osteoconductive capability and can undergo physiologic remodeling replaced by the host bone. Thus, it appears to be more effective than the hydroxyapatite grafts.

The introduction of short implants provided an alternative predictable treatment modality. They are accepted as the least invasive treatment with no need for other complicated surgical procedures. At the bone-implant interface, the highest load bearing area is located in the crestal 5mm. Despite that, less stresses are transmitted to the implant apical portion. Consequently, the placement of short implants is based on this biomechanical rationale.⁽¹³⁾

Since it was proven that the 10mm implant was the shortest implant with a predictable success, it is generally regarded as the standard length. However, the term “short implant” is still arguable. Some authors define it as implants which are no longer than 7mm. Others define it according to the length of the implant body completely submerged in the bony ridge; where if the calculated length is 8mm or less, then the implant is considered as a short implant.⁽³⁸⁾⁽³⁹⁾

For a dental implantologist, It is highly important to properly differentiate between the following scientific terms: (1) success rate; describing an ideal implant quality of health, (2) survival rate; indicating implant with less than ideal condition but still physically in the oral cavity, (3) failure rate; meaning implant that requires removal or has already been lost.⁽⁴⁰⁾ The success criteria proposed by Albrektsson et al. in 1986 are widely used nowadays.