ORIGINAL RESEARCH

Survival of Implants after Indirect Maxillary Sinus Elevation Procedure: A Two Years Longitudinal Study

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Abstract

Aim: The aim of the study was to evaluate the survival rate of two diverse implant systems with different implant surfaces with the same geometrical design.

Materials and methods: One hundred fifty patients were included in the study in which 95 were males and 55 were females and 150 implants were placed using indirect sinus floor elevation technique and only one implant was placed in each subject and they were categorized into two groups of 100 in group A and 50 in group B as per two different implant systems. At review appointments, implants were tested clinically and radiographically and were examined for signs of infection. The patients were examined periodically after placement of the implants, and follow-up was conducted annually.

Results: Results of the Chi-square analysis showed no significant association between the type of implant surface and rate of success or failure of the implant. There was no significant difference between the observed and expected frequency of successful implants in group A as well as group B, indicating that the surface type of implant had no significant association with the success of the implant in group A and B.

Conclusion: To date, there is no consensus in the literature regarding the best surface and even on the macrotopography of the implants for better osseointegration. However, Surface treatments improve the result of osseointegration, especially in the early stages, benefiting bone affixation with qualitative and quantitative enhancements. In the present study, we achieved clinical success with both kinds of implant surfaces however Bioetched implant surface showed promising results comparable to Tiunite surface of Nobel BioCare Implants. In the future, more case-controlled studies with longer follow-up are needed to validate the results of the present findings.

Keywords: Bio-etch, Calcium phosphosilicate, Indirect maxillary sinus lift, Osseointegration, Osteotome

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Introduction

Implant dentistry has changed its face in the last four decades dramatically. However, an implant placed in healthy patients has a predictable success rate of 95% which is satisfactory data to rely on. The clinical protocols and implant biomaterials also transformed in last many decades briefly as from delayed to immediate implant placements, external hex to conical hex implant connections and from very strict inclusion criteria to less strict protocols.[1,2]

Management of posterior atrophic maxilla is considered one of the most challenging areas to manage, extensive work has been done by the clinicians and researchers across the globe over its successful management. The two basic approaches of managing it are direct and indirect approach which are selected by the clinicians according to various aspects like Residual Bone Height and width, patient compliance, anatomy of the maxillary sinus and many more other factors. Due to the more invasive nature of the direct sinus elevation procedure, the clinicians shifted in search of easy, predictable and less morbid approach to rehabilitate posterior maxilla.

In the year 1994 Summer's introduced indirect sinus elevation approach using osteotomes called as osteotome mediated sinus floor elevation (OMSFE).[3] After its introduction, it is robustly popularized across the dental professionals, and till now modifications of the same are still explored for better results.

Apart from modifications in clinical protocols and biomaterials significant work is also done on implant surfaces for better, faster and long term osseointegration of the implants in the native as well as regenerated bone.[4] From smooth implant to rough implant surfaces,non-etched to etched, non-bioactivated to bioactivated are few of them.

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The quality of the implant surface determines the tissue reaction with peri-implant tissues. Surface quality is categorized into three aspects as a surface with mechanical properties, topographic properties, and physicochemical properties. All three aspects have a major role in determining the success of the implant-supported prosthesis.[5] However different implant manufacturers claim various surface properties in all three aspects. So, it is very crucial or even essential to precisely inspect the properties and select the best implant options available for the patient in the current scenario.

Our ultimate aim of the study was to evaluate the survival rate of two diverse implant systems with different implant surfaces with the same geometrical design.

Materials and Methods

The study was conducted at the private practices of three authors LM, PB, and AA, and all parameters were assessed by them. Ethical clearance was taken from the institutional review board, and the study was done after taking informed consent from the patients. One hundred fifty patients were included in the study in which 95 were males, and 55 were females and 150 implants were placed using indirect sinus floor elevation technique, and only one implant was placed in each subject, and they were categorized in two groups of 100 in group A and 50 in group B as per two different implant systems. The clinical condition for treatment included rehabilitation of single or multiple posterior maxillary teeth and with implant supported crown or bridge. The primary criteria for implant placement was a minimum residual bone height of 5–7 mm and residual bone width of 6 mm at the test site and the exclusion of systemic or any other contraindications to surgery. Initially, 188 patients were included in the study however 38 patients dropped from the study due to various reasons like no regular followup's, moved to other cities, etc. Out of 150 patients that finally met the criteria of the study, 95 were males and 55 were females (Flowchart 1) No patients were kept out from the study undergoing surgery taking tobacco in any form. The patients were allocated in both the groups using a coin toss method.

Surgical Protocol

First stage surgery was performed as per the desired surgical protocol, following the manufacturer's instructions. Majority of the implants were placed 3 months or more after tooth extraction, although some were placed immediately after the exodontias, the timing of implant placement was dependent on initial stability. A nonsub-merged technique was used for both the implants, i.e., of TOP DM (Bioner, Spain) and Nobel Biocare (CA, USA) and they are functionally loaded 4 months after surgical placement. The patients were examined periodically after placement of the implants every three months however data collection and assessment was conducted annually.

Flowchart 1: Study design

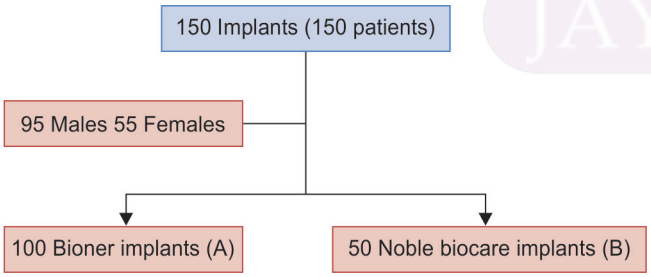

Table 1: Implant success outcome assessment criteria

Scale description	Remarks
0	Absence of clinical mobility with 500 g in any direction
1	Slight detectable horizontal movement
2	Moderate visible horizontal mobility up to 0.5 mm
3	Severe horizontal movement greater than 0.5 mm
4	Visible moderate to severe horizontal and any visible vertical movement

Cases included both flat and curved sinus floors and managed with Ostetomes and Osstem (Korea) CAS Kit respectively ,the biomaterial used for all the cases was a CalciumphospoSilicate putty (Novabone, FL, USA) due to ease of material dispensing system and a fast turnover rate of graft remodeling, also being in a putty form there are lesser chances of sinus membrane tears and the material spreads evenly in the grafted area, all implant lengths used had a length of 11.5 mm. Bioner Implant had a diameter of 4 mm and Noble Biocare was 4.2 mm, respectively.

Assessments at review appointments, implants were tested clinically and radiographically every six months and were examined for signs of infection.

Any adverse events told by the patients were recorded. Other records included oral hygiene and periodontal status; the findings were documented if they were presented to be outside the normal physiological range.

Implant Outcome (Success, Survival and Failure Criteria (adapted from Misch, 1999):[5] (Table 1)

Implants were classified in one of the following 3 classes according to the outcome:

Successful implant

Successful implants are classified as the one having no pain, zero mobility, less than 2 mm of bone loss from initial surgery having probing depth less than 5 mm with no history of exudation.

Surviving Implant

An implant that remained in situ and function, whether or not there were any complications, such as exudation, facial space infection, local implant fistula, pain or swelling at the implant site, purulent discharge, peri-implant radiolucency and/or marginal crestal bone loss greater than 4 mm.

Failed Implant

An implant that had been removed for any reason, e.g., pain, mobility or advanced bone loss during the study period.

Statistical Analysis

The data was entered into the excel sheet. Statistical analysis was performed using Statistical Package for Social Science (SPSS) 20.0 version (IBM, Chicago). Chi-square test was employed to assess the association between the type of Implant and success of implants. A *p* value less than 0.05 was considered statistically significant.

Results

There were no significant surgical complications experienced at the time of implant placement. All the indirect sinus lift procedures were uneventful. Postoperative healing was satisfactory. Functional loading was done three months after the surgery. A radiograph was taken on the regular follow-up for up to 2 years. There was no significant marginal bone loss observed on mesial and distal aspects of the implants. Out of 150 implants, only5 Implants have failed, i.e., two implants of Bioner Top DM and three implants of noble biocare divided into two groups as group A and group B, respectively (Tables 2 and 3). Implant survival was found to be satisfactory in both the groups using indirect maxillary sinus elevation technique.

Results of the Chi-square analysis showed no significant association between the type of implant surface and the rate of

Table 2: Study outcome

S. no.	*Implant type*	*Number of implant placement*	*Success/failure rate*
1	Bioner Top DM	100 implants	2 failures
2	Nobel Biocare	50 implants	3 failures

Table 4: Comparison of implant success

	Number of subjects (n)	*Successful implants*	
		Observed count	*p value**
A implant	100	98	0.198
B implant	50	47	
Total	150	145	

**p* value < 0.05 was considered statistically significant.
#Chi-square test

success or failure of the implant. The *p* value came out to be 0.198 and it confirms there was no significant difference in observed count and expected frequency of successful implants in group A as well as group B (Table 4), indicating that the surface type of implant had no significant association with the success of the implant in group A and B.

Discussion

Surface enhancement has become one of the most explored design parameters in implantology to increase the host-implant interaction as well as long term prognosis.[6,7] Thus, an an extensive array of surface modifications has become available under several rationales, and are primarily comprised by roughness and/or chemistry modifications.[8]

The original Brånemark implant (Nobel Biocare) was a turned screw (smooth surface) of minimal surface roughness, i.e., between 0.5 µm and 1.0 µm in Sa value. For a long time, this implant was the gold standard, based mainly on good clinical results.[9,10] In mid-90s research found an improved bone response with more rougher implant surface (1.5 µm) than turned (smooth) and plasma-sprayed implants.[11]

The ability of osseointegration of implants is precisely linked to a surface of the implant made up of dense and resistant oxide film, which is formed, spontaneously, when titanium comes in contact with the air or with the physiological fluids, the surface coating is responsible for titanium protection against corrosion and oxidation[12.] This oxide layer and its thickness and stability has a pivotal role in the success of implant as biomaterial as it prevents the phenomenon of corrosion and release of ions that are undesirable for the process of osseointegration.[13]

Implants with two different kinds of surfaces were used in the present study. Nobel Biocare Implant has tiunite surface treatment with surface roughness less than 2 um, on the other side, Bioner implants have Bio-Etch, i.e., double acid etch[14] without sandblasting with a mean surface roughness of 1.3 µm which is similar to other surfaces. Surface treatment of both implants used in the study are in accordance with the predictable surface treatments described in the literature, in addition, this surface is not having any metallic dirt like alumina over its surface that is one of the most common disadvantages of sandblasting process. Bioetching not only increase the bone to implant contact, but it also has faster osseointegration period hence reducing the healing time.[15-19]

Table 3: Frequency of successful and failed implants

Group	*Number of subjects (n)*	*Successful*	*Failed*
A Implant	100	98	2
B Implant	50	47	3
Total	150	145	5

The microtopography of the implant surface has been anticipated to act at the cellular level of osseointegration, nanotopography of the implant surface is thought to modify cell-implant interactions at the protein and cellular level.[20,21] Nanotechnology has received wide attention in public and scientific media, and its scale ranges from 1 to 100 nm. Fernanda et al. in 2017 observed enhanced osseointegration in a dual acid etched surface, Dual acid etched surface showed greatest surface roughness that provides conducive surface for favorable osseointegration which shows comparable results with other implant surfaces described in the literature.[22] There is a paucity of literature over a dual acid etched surface treated implant surface in the literature, and as per our knowledge, this paper is a first of its kind observed its outcome in cases of implant done with indirect maxillary sinus elevation. The present study shows a similar success rate using both types of implant systems however satisfactory outcome has been observed with Bioner and Nobel Biocare Implant systems.

Conclusion

Till date, there is no consensus in the literature regarding the best implant surface and even on the macrotopography of the implant systems for better osseointegration. However, Surface treatments improve the result of osseointegration, especially in the early stages, benefiting bone affixation with qualitative and quantitative enhancements. In the present study, we achieved clinical success with both types of implant surfaces; however, Bioetched implant surface showed promising results comparable to Tiunite surface of Nobel BioCare Implants. In the future,case-controlled studies with longer follow-up and larger sample size are needed to validate the results of the present findings.

Limitations

The present study has a limitation of smaller sample size and shorter follow-up period. Studies with large sample, multicentric and long term followup are needed to prove the above fact.

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