

Evaluation of Survival Rates of Dental Implants Placed Using Indirect Sinus Floor Elevation With and Without Bone Grafts – A Systematic Review & Meta-Analysis

Dr. Darshana Shah,¹ Dr. Chirag Chauhan,² Dr. Drashti Pandya,³ Dr. Krina Merchant,⁴
Dr. Nidhi Rathod⁵

1. Dr. Darshana Shah

Department of Maxillofacial Prosthodontics and Crown and Bridge and Implantology, Ahmedabad Dental College and Hospital, Near Hare Krishna Mandir, Bhadaj Ranchodpura Road, Ahmedabad, Gujarat - 382115

2. Dr. Chirag Chauhan

Department of Maxillofacial Prosthodontics and Crown and Bridge and Implantology, Ahmedabad Dental College and Hospital, Near Hare Krishna Mandir, Bhadaj Ranchodpura Road, Ahmedabad, Gujarat - 382115

3. Dr. Drashti Pandya

Department of Maxillofacial Prosthodontics and Crown and Bridge and Implantology, Ahmedabad Dental College and Hospital, Near Hare Krishna Mandir, Bhadaj Ranchodpura Road, Ahmedabad, Gujarat - 382115

4. Dr. Krina Merchant

Department of Maxillofacial Prosthodontics and Crown and Bridge and Implantology, Ahmedabad Dental College and Hospital, Near Hare Krishna Mandir, Bhadaj Ranchodpura Road, Ahmedabad, Gujarat - 382115

5. Dr. Nidhi Rathod

Department of Maxillofacial Prosthodontics and Crown and Bridge and Implantology, Ahmedabad Dental College and Hospital, Near Hare Krishna Mandir, Bhadaj Ranchodpura Road, Ahmedabad, Gujarat - 382115

CORRESPONDING AUTHOR

Dr. Drashti Pandya

'KASHI' B21 Krushna Kunj Soc 1, Waghodia Dabhoi Ring Road,
Vadodara, Gujarat -383315

Mobile - +91-7567170770

Email - drashtipandya28@gmail.com

Abstract

Purpose: The aim of this systematic review is to evaluate the survival rate of implants placed using indirect sinus floor elevation with and without bone grafts.

Material and Methods: The electronic databases, such as MEDLINE, EMBASE, PUBMED and CENTRAL were systematically and manually searched. Thirteen studies fulfilled the inclusion criteria. The included articles were subjected to quantitative analysis, and the meta-analysis was carried out.

Results: The included studies were of moderate quality, with overall implant survival rate for grafted implant to be 96.50% and for nongrafted implants 97.40% after follow-up period of more than 1 year. This indicated that the osteotome sinus floor elevation technique with or without grafting were both predictable.

Conclusion: Within the limitations of the study, it can be concluded that the implant survival rate for grafted and nongrafted maxillary sinus are predictable. And we can assume that there are many other factors affecting the survival rates of dental implants with osteotome sinus floor elevation in grafted and nongrafted implants.

Keywords: Maxillary sinus augmentation, bone grafts, indirect sinus floor elevation, dental implants, osteotome sinus floor elevation, marginal bone loss

INTRODUCTION

Today, dental implants have become the most accepted and predictive treatment for prosthetic rehabilitation of missing teeth to restore both function and form optimally.¹

However, reduced bone height below the maxillary sinus in the posterior maxillary region offers some limitations in the placement of dental implants.² Various options have been developed to solve this problem, including application of short implants, tilted implants, zygomatic implants, and sinus augmentation.³

Bone regeneration in posterior maxillary region can be achieved for dental implant placement using various maxillary sinus floor elevation techniques, such as direct and indirect sinus floor elevations with use of bone grafts and bone substitutes, for sufficient bone volume.⁴

However, several recent studies have shown to achieve a significant amount of bone formation at the sinus floor following maxillary sinus elevation and simultaneous implant placement, without any bone grafting material.⁴

The purpose of this systematic review was to evaluate implant survival rate (SR) after maxillary sinus floor elevation with and without bone grafts.

Aim

The aim of this systematic review is to evaluate the survival rate of implants placed using indirect sinus floor elevation with and without bone grafts.

Objectives

- To evaluate the survival rate of implants in patients with indirect sinus floor elevation with bone grafts.

- To evaluate the survival rate of implants in patients with indirect sinus floor elevation without bone grafts.
- To evaluate the marginal bone loss around implants in patients with indirect sinus floor elevation with and without bone grafts.

MATERIAL AND METHODS

Search Strategy

An electronic search was conducted for articles in English, listed with **PubMed, Medline and Embase** from 2007 to now.

Review articles as well as references from different studies were also used to identify the relevant articles.

Selection of Studies

The review process consists of two phases. **In the first phase**, titles were screened to assess the relevance. Case reports, reviews and in vitro studies were excluded. The remaining articles were further screened by reading abstracts. Any disagreements were solved by discussion or third author suggestions, if any. The hand searches of selected journals as well as search of references of the selected studies were also done. The articles obtained after this first step of the review process were on the basis of inclusion and exclusion criteria. **In the second phase**, relevant and suitable articles were isolated for further processing and data extraction. Duplicates and articles with insufficient necessary data were excluded by the two authors and any disagreements were resolved by the third author's suggestions.

Inclusion Criteria

- Study designs - Prospective and Retrospective Studies as well as Case Series.
- Human subjects.
- Studies including data of sinus floor elevation with and without bone grafts and subsequent implant placement.
- Minimum 6 months follow up period.
- Studies including patients above 18 years of age and with good general health.

Exclusion Criteria

- Studies with sinus lift procedure without subsequent implant placement.
- Studies using methods other than indirect method for sinus lift procedure.
- No data on implant survival rates
- No data on subsequent implant placement
- Studies with local, acute, or chronic sinus pathology
- Animal studies
- In vitro studies
- Follow up period less than 6 months

FIGURE 1 - Flowchart of the Search Strategy

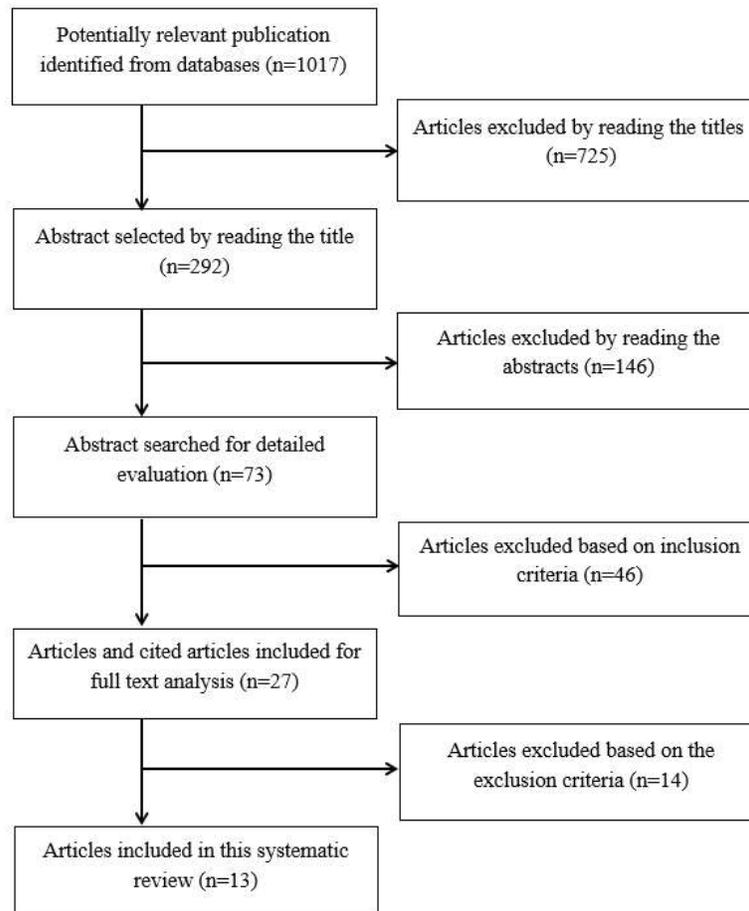


TABLE 1: Description of Characteristics of Included Studies

Author	Patients	No. of Implants	Loading Protocol	Follow Up	Mbl Grafted Implants (MM)	Mbl Non Grafted Implants (MM)	Survival Rate Grafted Implants	Survival Rate Non Grafted Implants
JOHANSSON ⁵ (2010)	65	81	DELAYED	5	0.13 ± 0.10	NM	98.8%	NM
OZKAN ⁶ (2011)	28	84	IMMEDIATE	5	0.34 ± 0.07	NM	100%	NM
LUDOVICO ⁷ (2011)	93	282	DELAYED IMMEDIATE	2	1.5 ± 1.0 0.7 ± 1.0	NM	96.5% 99.3%	NM
CHIRSTER ⁸ (2012)	11	62	IMMEDIATE	1	0.43 ± 0.20	NM	96.8%	NM
NEDIR ⁹ (2013)	12	37	DELAYED	1	0.4 ± 0.7	0.6 ± 0.8	90%	100%
MARKOVIC ¹⁰ (2015)	45	180	DELAYED	2	NM	NM	100%	100%
NEDIR ¹¹ (2015)	17	25	DELAYED	10	NM	1.0 ± 0.9	NM	100%
SI ² (2016)	80	96	DELAYED	9	NM	0.5 ± 1.69	NM	90.6%
CABAN ¹² (2017)	25	34	DELAYED	10	NM	0.6 ± 0.8	NM	100%
EMAD ¹³ (2018)	31	77	IMMEDIATE	10	NM	0.47 ± 1.17	NM	93.6%
RAWAT ¹ (2019)	21	26	DELAYED	6 months	NM	0.4 ± 0.2	NM	100%
QIAN ¹⁴ (2020)	45	45	DELAYED	10	1.67 ± 1.06	1.52 ± 1.08	90.7%	95%
LUMBAU ¹⁵ (2021)	96	105	DELAYED	5	1.24 ± 0.28	NM	NM	98.1%

TABLE 2: Evidence Level of Selected Articles

S.NO.	AUTHOR	YEAR	STUDY DESIGN	EVIDENCE LEVEL
1	JOHANSSON et al ⁵	2010	Prospective Study	2
2	OZKAN et al ⁶	2011	Prospective Study	2
3	LUDOVICO et al ⁷	2011	Retrospective Study	3
4	CHIRSTER et al ⁸	2012	Prospective Study	2
5	NEDIR et al ⁹	2013	Randomized Control Trial	1
6	MARKOVIC et al ¹⁰	2015	Randomized Control Trial	1
7	NEDIR et al ¹¹	2015	Prospective Study	2
8	SI et al ²	2016	Retrospective Study	3
9	CABAN et al ¹²	2017	Retrospective Study	3
10	EMAD et al ¹³	2018	Prospective Study	2
11	RAWAT et al ¹	2019	Prospective Study	2
12	QIAN et al ¹⁴	2020	Randomized Control Trial	1
13	LUMBAU et al ¹⁵	2021	Retrospective study	3

TABLE 3: Excluded Studies and the Reason for Exclusion

S.NO.	AUTHOR	YEAR	REASON FOR EXCLUSION
1	Nicola et al ¹⁶	2008	Clinical study
2	Lai et al ¹⁷	2010	Preliminary Clinical trial
3	Silvio et al ¹⁸	2012	Literature review
4	Rajkumar et al ⁵	2013	Direct sinus elevation used
5	Waleed et al ¹⁹	2017	No data on implant survival rates
6	Garg et al ²⁰	2018	Case report
7	Gatti et al ²¹	2018	No data on implant survival rates
8	Zhao et al ²²	2018	No data on subsequent implant placement
9	ZHU et al ²³	2018	Lateral window technique used
10	Trinh et al ²⁴	2019	No data on implant survival rates
11	Liat Chaushu et al ²⁵	2020	No data on survival rates
12	Pe-yi kuo et al ²⁶	2021	No data on survival rates
13	Stacchi et al ²⁷	2021	No data on subsequent implant placement
14	Choudhary et al ²⁸	2022	No data on implant survival rates

RESULTS

Meta-Analysis: Proportion	
Variable for studies	AUTHOR
SURVIVAL RATE	NON GRAFTED IMPLANTS
Variable for total number of cases	NO._OF_IMPLANTS
Variable for number of positive cases	PATIENTS

Study	Sample Size	Proportion (%)	95% CI	Weight (%)		Survival Rate Non Grafted Implants
				Fixed	Random	
NEDIR (2013) ⁹	37	32.432	18.014 to 49.785	5.98	10.99	100
MARKOVIC (2015) ¹⁰	180	25.000	18.857 to 31.986	28.50	11.46	100
NEDIR (2015) ¹¹	25	68.000	46.500 to 85.050	4.09	10.73	100
SI (2016) ²	96	83.333	74.350 to 90.163	15.28	11.35	90.6
CABAN (2017) ¹²	34	73.529	55.638 to 87.118	5.51	10.94	100
EMAD (2018) ¹³	77	40.260	29.234 to 52.059	12.28	11.29	93.6
RAWAT (2019) ¹	26	80.769	60.649 to 93.445	4.25	10.76	100
QIAN (2020) ¹⁴	45	97.826	88.473 to 99.945	7.40	11.10	95
LUMBAU (2021) ¹⁵	105	91.429	84.352 to 96.005	16.69	11.37	98.1
Total (fixed effects)	626	61.668	57.760 to 65.466	100.00	100.00	
Total (random effects)	626	67.834	45.189 to 86.755	100.00	100.00	

Test for Heterogeneity

Q	261.6243
DF	8
Significance level	P < 0.0001
I² (inconsistency)	96.94%
95% CI for I²	95.62 to 97.87

Publication Bias

Egger's Test	
Intercept	6.0515
95% CI	-8.0791 to 20.1821
Significance level	P = 0.3449
Begg's Test	
Kendall's Tau	0.0000
Significance level	P = 1.0000

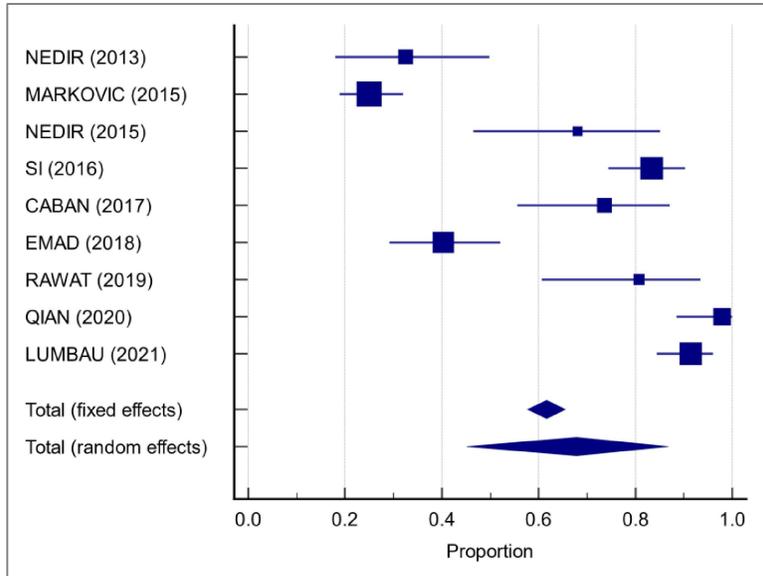


Figure 2: Forest Plot of Survival Rate for Non-Grafted Implants

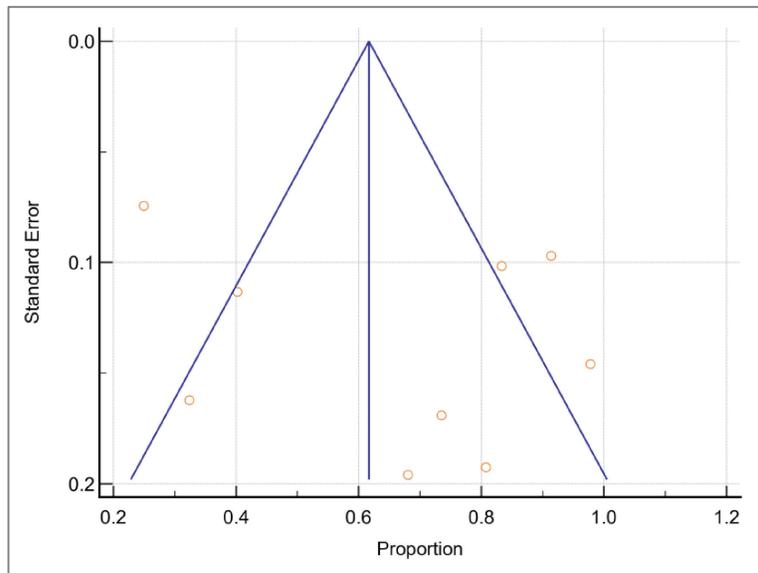


Figure 3: Funnel Plot of Survival Rate for Non-Grafted Implants

Meta-Analysis: Proportion	
Variable for studies	AUTHOR
SURVIVAL RATE	GRAFTED IMPLANTS
Variable for total number of cases	NO._OF_IMPLANTS
Variable for number of positive cases	PATIENTS

Study	Sample Size	Proportion (%)	95% CI	Weight (%)		Survival Rate Non Grafted Implants
				Fixed	Random	
JOHANSSON (2010) ⁵	81	80.247	69.914 to 88.267	10.53	14.35	98.8
OZKAN (2011) ⁶	84	33.333	23.419 to 44.462	10.91	14.37	100
LUDOVICO (2011) ⁷	282	32.979	27.519 to 38.801	36.33	14.74	96.5
CHIRSTER (2012) ⁸	62	17.742	9.204 to 29.531	8.09	14.19	96.8
NEDIR (2013) ⁹	37	32.432	18.014 to 49.785	4.88	13.75	90
MARKOVIC (2015) ¹⁰	180	25.000	18.857 to 31.986	23.23	14.65	100
QIAN (2020) ¹⁴	45	97.826	88.473 to 99.945	6.03	13.96	90.7
Total (fixed effects)	772	39.326	35.877 to 42.855	100.00	100.00	
Total (random effects)	772	47.029	26.866 to 67.712	100.00	100.00	

Test for Heterogeneity

Q	194.1213
DF	6
Significance level	P < 0.0001
I ² (inconsistency)	96.91%
95% CI for I ²	95.32 to 97.96

Publication Bias

Egger's Test	
Intercept	6.9701
95% CI	-9.0710 to 23.0113
Significance level	P = 0.3148
Begg's Test	
Kendall's Tau	0.4286
Significance level	P = 0.1765

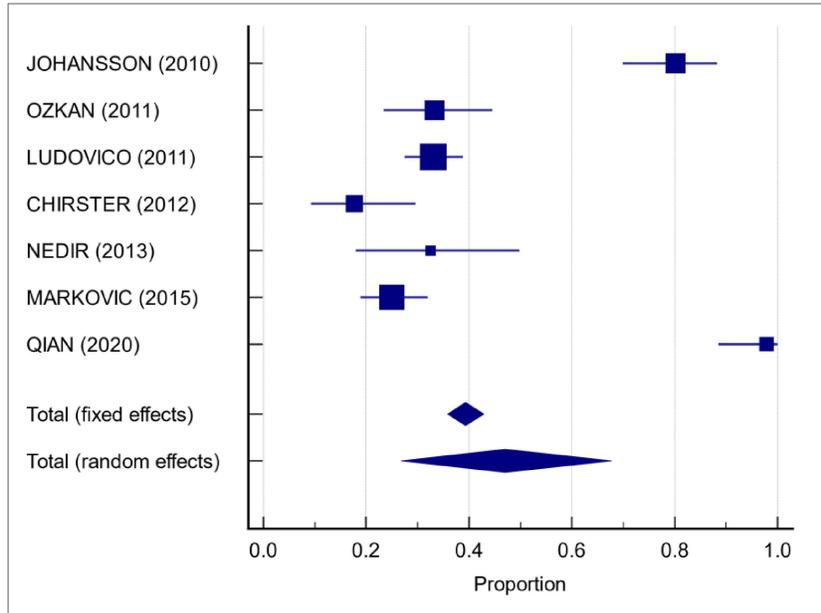


Figure 4: Forest Plot of Survival Rate for Grafted Implants

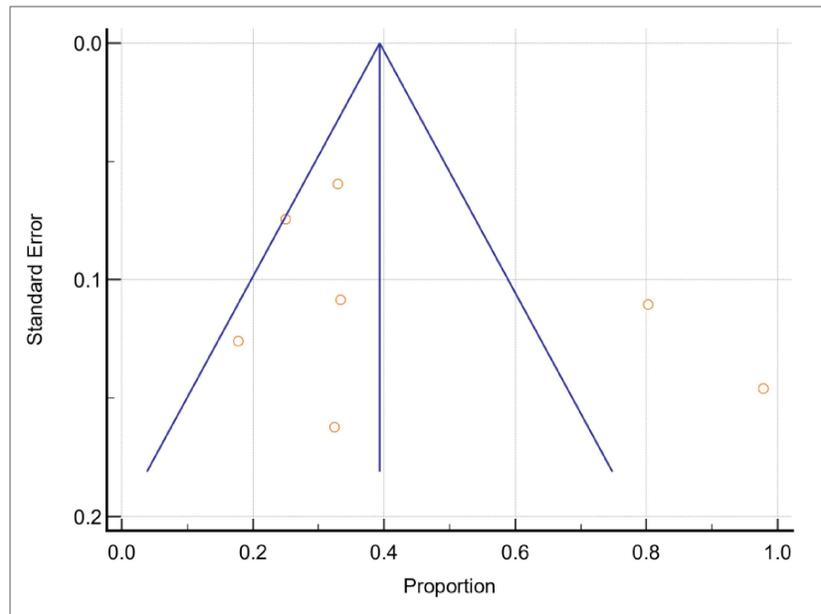
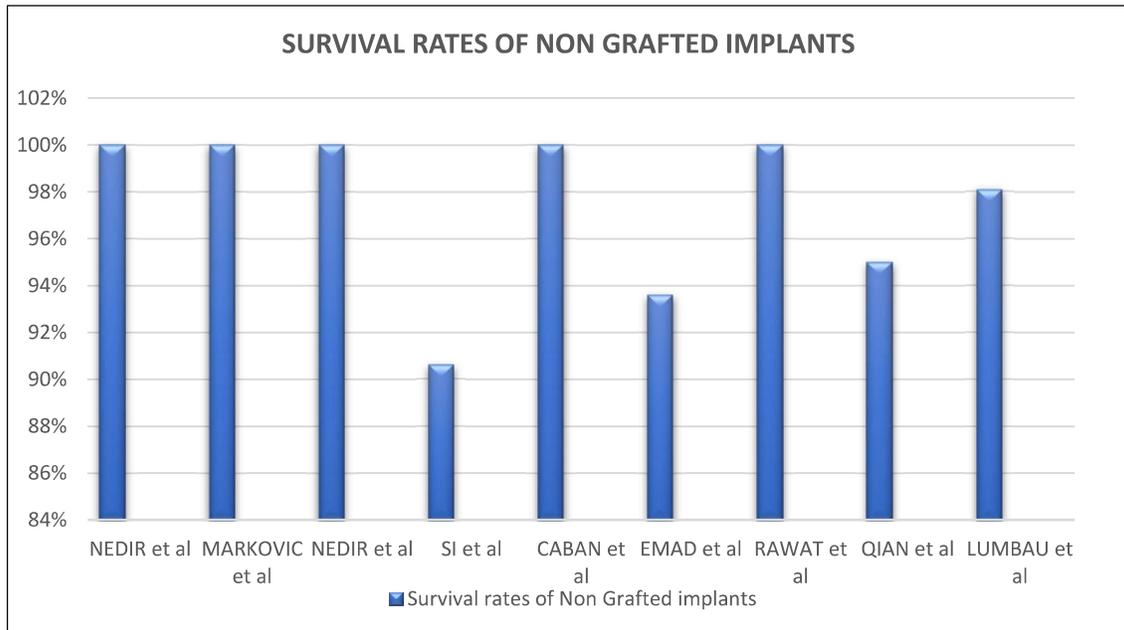
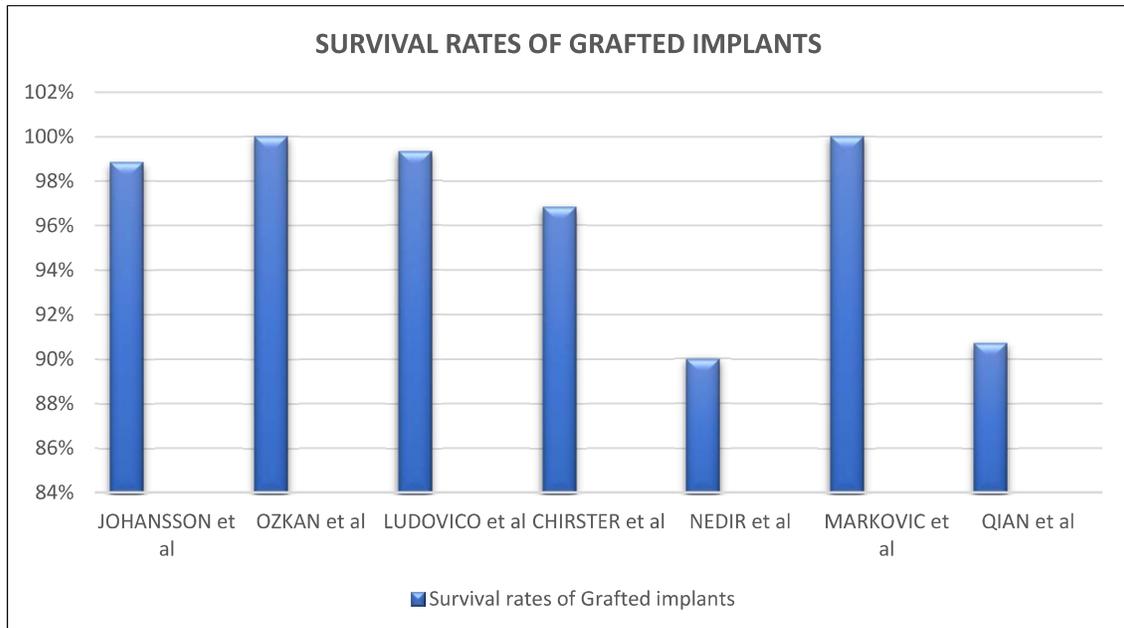


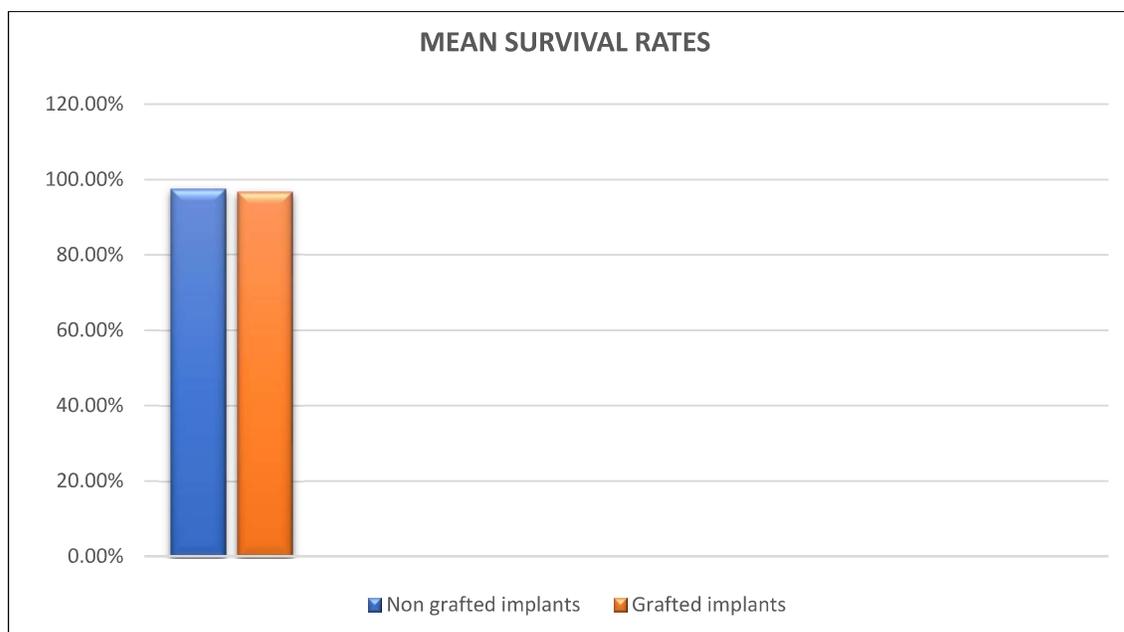
Figure 5: Funnel Plot of Survival Rate for Grafted Implants

GRAPH 1 - SURVIVAL RATES OF NON-GRAFTED IMPLANTS



GRAPH 2 - SURVIVAL RATES OF GRAFTED IMPLANTS





GRAPH 3 - MEAN IMPLANT SURVIVAL RATES

DISCUSSION

Osteotome-mediated sinus lifting technique has been demonstrated to be a viable alternative option in implant rehabilitation of atrophic posterior maxilla as it has been considered less invasive than the window technique of sinus augmentation.²⁹

There are two options for indirect sinus floor elevation: with the use of bone grafting material or without using bone graft. There are various advantages of indirect sinus floor elevation without using bone graft compared to grafting such as reduced operation time, post-operative morbidity and cost as the expenses for grafting materials is reduced.²

In that line, Winter *et al.* in 2002 obtained a success rate of 91.4% after 22 months loading in implants placed in an atrophic alveolar ridge with <4mm bone without using bone grafting.³⁰

A prospective study by Merheb *et al.* compared the 5-year progression of implant stability in grafted and non-grafted sites placed using osteotome sinus floor elevation. And showed that the stability of implants in non-grafted sites is similar to that of implants placed in grafted sites.³¹

The present review is focused on implant survival rates after OSFE with and without grafting. The survival rate of nongrafted implants was found to be 97.40% and for that of grafted implants was 96.50%. The meta-analysis found no significant difference between survival rates of grafted and nongrafted groups. This indicated that the OSFE technique with or without grafting were both predictable.

Within the limitations of this study we can assume that there are many other factors affecting the survival rates of dental implants with osteotome sinus floor elevation in grafted and nongrafted implants. Thus, more high-level evidence is needed to evaluate the clinical outcomes following OSFE with and without grafting in the long term.

CONCLUSION

In conclusion, this systematic review and meta-analysis showed high survival rates for implants placed in non-grafted maxillary sinus lifts and conventional sinus lift using augmentation materials. The osteotome sinus floor elevation techniques with and without bone grafting were both predictable in the short term.

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