

Influence of smoking and oral hygiene

on success of implants placed after direct sinus lift

Abstract

Objective

The objective of this study was to evaluate the influence of smoking and oral hygiene on the success and periimplant marginal bone loss of implants placed in one-stage and two-stage direct sinus lift procedures.

Materials and methods

A retrospective clinical study of patients who underwent direct sinus lift and implant placement was conducted. Forty-six patients with 58 direct sinus lifts were included and a total of 102 implants were placed. Cigarette consumption was quantified and the level of oral hygiene determined at the time of surgery using a simplified calculus and plaque index. Bone loss and implant success (according to Buser's criteria) were monitored after 12 months of prosthetic loading.

Results

The success rate for implants placed after direct sinus lift was 93.1% at 12 months. There was a higher success rate in nonsmokers (94.2%) than in smokers (90.9%), with a mean bone loss of 0.52 mm (range: 0.21–0.84 mm) in nonsmokers and 0.60 mm (0.24–0.92 mm) in smokers at the 12-month follow-up. The success rate in patients with poor oral hygiene was lower (81.8%) than in patients with good (95.5%) or regular hygiene (92.3%). Furthermore, there was a mean bone loss of 0.51 mm (0.21–0.82 mm) in patients with good oral hygiene, 0.57 mm (0.24–0.82) with regular hygiene and 0.66 mm with poor hygiene (0.32–0.92 mm). There was no statistically significant relationship ($p > 0.05$) between bone loss or implant success and smoking or oral hygiene.

Conclusion

Within its limitations, the present investigation suggests that smoking and poor oral hygiene may negatively influence the outcome of implants placed both in one-stage and two-stage direct sinus lift procedures. However, differences were in no case statistically significant and studies with larger sample sizes should be conducted to corroborate or refute these findings.

Keywords

Sinus lift, oral hygiene, smoking, bone loss.

Introduction

Placing implants in the posterior maxilla can be a complex procedure when there is atrophy of the alveolar ridge and maxillary sinus pneumatization. In some cases, these anatomical limitations may be overcome using sinus lift procedures.¹ The success rates of implants placed after sinus lift are similar to those of implants placed in mature bone.² However, the residual alveolar bone height appears to influence implant survival. Rios et al. conducted a systematic review and divided the outcomes into two groups according to residual bone height: ≤ 4 mm in Group 1 and > 4 mm in Group 2.³ The implant survival rate was 96% (range: 80–100%) for Group 1 and 99% (range: 97–100%) for Group 2.³

In addition to bone atrophy, factors such as smoking and poor oral hygiene have been suggested to increase the risk of implant failure in the posterior maxilla.⁴ Several studies have addressed the association between smoking and the outcome of implants placed using conventional techniques;^{5–7} however, few studies have addressed the influence of smoking on the success of implants placed after direct maxillary sinus lift. In all of the published studies, higher tobacco consumption yielded higher complication and/or implant failure rates;^{8–15, 1, 16–19} however, this effect was not always statistically significant (**Table 1**).^{6, 12–14}

The influence of oral hygiene has frequently been considered in implant studies. In some studies, poor hygiene was associated with higher periimplant marginal bone loss.²⁰ Contrarily, other studies did not find this relationship.^{21–23} However, evidence relating patient oral hygiene to the outcome of implants placed after direct sinus lift procedures is scarce. Only one study was found, and it reported a statistically significantly higher implant failure rate in patients with poor oral hygiene.¹¹

The objective of this study was to evaluate the influence of smoking and oral hygiene on the success and periimplant marginal bone loss of implants placed in one-stage and two-stage direct sinus lift procedures.

Materials & methods

The study was approved by the University of Valencia ethics committee (#H1410262226693). All patients gave written informed consent before surgery, in accordance with the principles of the Declaration of Helsinki.

Study sample

A retrospective clinical study was performed between September 2009 and June 2012 of patients treated with dental implants placed in one-stage (simultaneous) and two-stage (delayed) direct sinus lift procedures. A minimum follow-up period of 12 months after implant loading was requested. Patients who failed to attend scheduled follow-up visits were excluded.

Surgical procedures

All of the procedures were performed by two expert surgeons, professors at the Oral Surgery Unit, Department of Stomatology, University of Valencia, under local anesthesia with 4% articaine and 1:100,000 epinephrine (Laboratorios Inbisa, Lliçà de Vall, Spain). Full-thickness flaps were raised. A window in the sinus lateral wall was made with round tungsten carbide burs and finalized with ultrasonic tips. The sinus membrane was detached with curettes and elevated using a bone graft material. A xenograft (Geistlich Bio-Oss, Geistlich Pharma, Wolhusen, Switzerland) was used as the only bone graft material (1.5–2 g). The sinus window was covered with a resorbable membrane (Geistlich Bio-Gide, Geistlich Pharma, Wolhusen, Switzerland). The implants used in this study were TSA implants with an Avantblast surface (Phibo Dental Solutions, Sentmenat, Spain). Implants were placed in the same surgery if the residual bone height was 4–6 mm, or delayed by six months if the height was < 4 mm.

All of the patients were prescribed the same postoperative medication: amoxicillin and clavulanic acid (Augmentin, GlaxoSmithKline, Madrid, Spain) 500 mg/8 h for seven days, ibuprofen (Bexistar, Laboratorio Barcino, Barcelona, Spain) 600 mg/8 h for three days, and a 0.12% chlorhexidine mouthrinse (GUM, Sunstar Americas, Chicago, Ill., U.S.) t.i.d. for seven days.

Data collection

Patient oral hygiene was evaluated using the Simplified Oral Hygiene Index (OHI-S).²⁴ This was obtained by measuring the presence of debris and calculus on the buccal surfaces of the maxillary right central incisor, mandibular left central incisor and maxillary first molars, as well as on the lingual surfaces of the mandibular first molars. The criteria for classifying debris were as follows: no debris, no stains (0); soft debris covering less than one-third of the tooth surface (1); soft debris covering more than one-third, but less than two-thirds of the exposed tooth surface (2); and soft debris covering more than two-thirds of the exposed tooth surface (3). The criteria for classifying calculus were as follows: no calculus (0); supragingival calculus covering less than one-third of the exposed tooth surface (1); supragingival calculus covering more than one-third, but less than two-thirds of the exposed tooth surface (2); and supragingival calculus covering more than two-thirds of the exposed tooth surface (3). The OHI-S was obtained from the combination of the two subindices. The grading scale was 0–1.2 (good oral hygiene), 1.3–3 (regular oral hygiene), or 3.1–6 (poor oral hygiene). Each patient was classified as having good oral hygiene, regular oral hygiene or poor oral hygiene.

The implant success rate was recorded according to the clinical and radiographic criteria of Buser et al.²⁵ Implants were classified as successful if they fulfilled all of the criteria (absence of clinically detectable implant mobility, absence of pain or any subjective sensation, absence of recurrent periimplant infection, and absence of continuous radiolucency around the implant after 12 months of loading) and as failed if any criterion was not met.

Radiographic examination was performed with an X-Mind intra-oral system (ACTEON MÉDICO-DENTAL IBÉRICA, Sentmenat, Spain) and an RVG intra-oral digital receptor (RVG 5100, Carestream Dental, Atlanta, Ga., U.S.). In order to reproduce the patient alignments, the Rinn XCP system (DENTSPLY, Des Plaines, Ill., U.S.) was used with a bite registration material in the area in which the parallelometer was fixed. Marginal implant bone loss was measured in millimeters using the RVG software. For measurement purposes, two visible and easily locatable reference points were selected at the junction point between the implant and prosthetic restoration. A straight line was traced between these two reference points

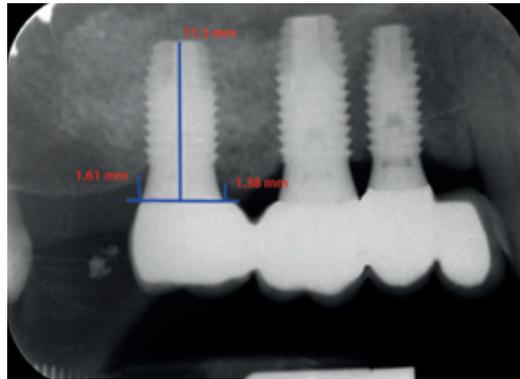


Fig. 1

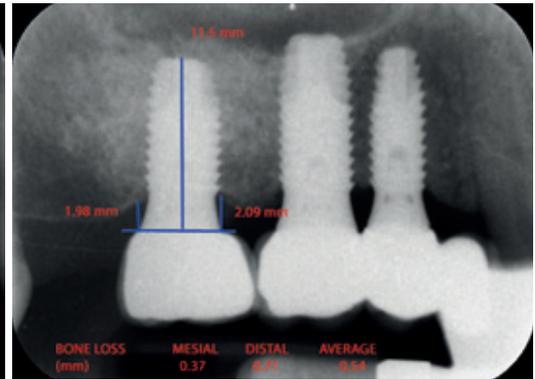


Fig. 2

Fig. 1
Radiographic assessment of bone level at implant loading.

Fig. 2
Radiographic assessment of bone level 12 months after loading.

and was considered to represent zero height. In order to determine bone loss, a perpendicular line was traced mesial and distal to the implant from zero height to contact with the bone (**Fig. 1**). The difference between the value recorded at the time of implant loading and after one year of loading was used to calculate bone loss mesial and distal to the implant. The largest value, either mesial or distal, was used as the bone loss value for that implant (**Fig. 2**).²⁶

Smoking and oral hygiene were recorded at the time of surgery. A patient who smoked > 1 cigarette/day was considered a smoker following the definition by Wallace.²⁷ Bone loss and success were recorded at 12 months of prosthetic loading.

Statistical analysis

A descriptive analysis was performed of the study variables, with their corresponding frequency distributions and measures of central tendency and dispersion. Statistical comparisons between the groups were conducted using the chi-squared test and Student's *t*-test. The SPSS for Windows statistical software package (Version 15.0; SPSS, Chicago, Ill, U.S.) was used throughout. Statistical significance was considered for $p < 0.05$.

Results

Fifty patients treated with direct sinus lift and implants were monitored during the study period. Four patients failed to attend scheduled follow-up visits and were thus excluded. The final sample consisted of 46 patients (16 men and 30 women) with a mean age of 49 (range: 29–69 years). These patients underwent 58 direct maxillary sinus lift procedures and received a total of 102 implants in the grafted sites: 50 were placed simultaneously with the sinus lift procedure and 52 were placed six

months thereafter. Implant lengths and diameters are detailed in **Table 2**.

Seven implants failed, all prior to loading, yielding an overall implant success rate of 93.1% at 12 months of loading. Five of these implants had been placed simultaneously and two implants six months after the grafting procedure. The survival was 90.0% for implants placed simultaneously and 96.2% for delayed implants. Overall, the mean periimplant marginal bone loss was 0.58 mm (range: 0.24–0.95 mm). Implants placed simultaneously had a mean bone loss of 0.62 mm (range: 0.21–0.97 mm) and implants placed in a second procedure of 0.54 mm (range: 0.27–0.93 mm; **Table 3**).

With respect to smoking, 69 implants were placed in nonsmokers and 33 in smokers. Nonsmokers presented a higher implant success rate at 12 months (94.2%) and lower mean bone loss (0.52 mm; range: 0.21–0.84 mm) than smokers (90.9% and 0.60 mm; range: 0.24–0.92 mm; **Table 4**). However, these differences were not statistically significant.

In relation to oral hygiene, 47 of the 102 implants were placed in patients with good oral hygiene, 42 with regular and 13 with poor hygiene. In patients with poor oral hygiene, the success rate at 12 months was lower (81.8%), compared with patients with regular (92.3%) or good hygiene (95.5%). Mean bone loss at 12 months was 0.51 mm (range: 0.21–0.82 mm) in patients with good oral hygiene, 0.57 mm (range: 0.24–0.82 mm) in patients with regular hygiene, and 0.66 mm in those with poor hygiene (range: 0.32–0.92 mm; **Table 5**). The observed differences were in no case statistically significant. The survival rate of implants placed in patients with poor oral hygiene was lower than in patients with regular or good hygiene. These differences were close to statistical significance ($p = 0.058$).

Table 1

Study	No. of patients	No. of implants	Relationship between smoking and implant success (p-value)	Relationship between oral hygiene and implant success (p-value)
Blomqvist et al. ⁸	49	314	0.977	NS
Jensen et al. ⁹	1007	2997	< 0.05*	NS
Kan et al. ¹⁰	60	228	0.027*	NS
Kan et al. ¹¹	60	228	0.027*	< 0.05*
Levin et al. ¹²	56	– (143 DSL)	0.06	NS
Beaumont et al. ¹³	45	– (59 DSL)	> 0.05	NS
Peleg et al. ¹⁴	731	2132	0.394	NS
Barone et al. ¹⁵	70	287	< 0.05*	NS
Huynh-Ba et al. ¹	57	116	0.025*	NS
Lin et al. ¹⁶	75	155	< 0.05*	NS
Testori et al. ¹⁷	106	328	< 0.05**	NS
Zinser et al. ¹⁸	224	1045	0.009*	NS
Cha et al. ¹⁹	161	462	0.0003*	NS

*Significant differences; **significant differences only for > 15 cigarettes/day.

Table 2

Length (mm)	Diameter (mm)		
	3.6	4.2	5.5
10.0	1	8	13
11.5	10	48	3
13.0	0	19	0

Table 1
Effect of smoking and oral hygiene on success of implants placed after direct sinus lift (DSL = direct sinus lift; NS: not studied).

Table 3

Implant placement	No. of implants	No. failed	12 months after loading	
			Success rate (%)	Mean bone loss (mm)
Immediate	50	5	90.0	0.62
Delayed	52	2	96.2	0.54
Total	102	7	93.1	0.58
			$p > 0.05$	$p > 0.05$

Table 2
Number of implants placed according to length and diameter.

Table 3
Number of implants placed and failed, success rate and mean bone loss according to immediate or delayed placement of implants.

Table 4

Smoking status	No. of implants	12 months after loading	
		Success rate (%)	Mean bone loss (mm)
Nonsmokers	69	94.2	0.52
Smokers	33	90.9	0.60
		$p > 0.05$	$p > 0.05$

Table 4
Number of implants, success rate and mean bone loss in relation to smoking.

Table 5

Oral hygiene	No. of implants	12 months after loading	
		Success rate (%)	Mean bone loss (mm)
Good	47	95.5	0.51
Regular	42	92.3	0.57
Poor	13	81.8	0.66
		$p > 0.05$	$p > 0.05$

Table 5
Number of implants, success rate and mean bone loss in relation to oral hygiene.

Discussion

Direct maxillary sinus lift is a predictable procedure. Pjetursson et al. performed a systematic review to assess the survival of implants after sinus lift.²⁸ Meta-analysis indicated an estimated annual failure rate of 3.48% (95% confidence interval: 2.48–4.88%), which translated into a three-year implant survival of 90.1% (95% confidence interval: 86.4–92.8%).²⁸ These results are similar to

those obtained in the present study: a success rate of 93.1% for 102 implants placed after 58 direct sinus lifts.

The mean bone loss at 12 months was 0.62 mm for simultaneously placed implants and 0.54 mm for those placed in a second stage. No statistically significant differences were observed. These results were similar to those of Felice et al.: one year after loading, one-stage-treated implants lost an average of 1.01 mm of periimplant bone and two-stage sites about 0.93 mm.²⁹ Similarly, after one year of follow-up, Jodia et al.³⁰ reported a marginal bone loss of between 0.68 and 1.22 mm for simultaneously placed implants, and Kahnberg and Vannas-Löfqvist³¹ of 0.8 mm for implants placed in a delayed mode.

In the literature, smoking has often been associated with a higher failure rate for conventionally placed dental implants,^{32–35, 7} worse osseointegration, as well as more frequent periimplantitis, bone loss and bleeding.^{36, 37} However, in studies published on sinus lift, there is no unanimity regarding the effect of smoking on treatment outcomes. In five of the reviewed studies (**Table 1**), statistically significant differences were found, observing a higher success rate in nonsmokers than in smokers.^{9, 10, 11, 15, 1} In one study, only smoking > 15 cigarettes/day and a residual ridge height of < 4 mm were significantly associated with reduced implant survival.¹⁷ In other studies,^{8, 12–14} no statistically significant relationship was found between smoking and implant success, although failure rates were higher among smokers. Moreover, Levin et al. observed relevant complications in one-third of the smokers, compared with only 7.7% of the nonsmokers.¹²

A recent systematic review evaluated the effects of tobacco smoking on the survival rate of dental implants placed in areas of maxillary sinus lift. Eight studies, three prospective and five retrospective, were included. Smoking was associated with increased implant failure rates in most individual studies and in the overall meta-analysis. However, when only prospective studies were considered, no significant differences in implant failure were observed between smokers and nonsmokers.³⁸ Similar results were obtained in this study: the implant failure rate and bone loss were slightly higher in smokers, but with the available sample size these differences were not statistically significant.

The literature clearly demonstrates the negative response of the periimplant mucosa to plaque accumulation;^{39–41} however, there is disagreement regarding the influence of oral hygiene on the success of conventionally placed implants. Mombelli et al.,²¹ Smith and Zarb,²² and Baelum and Ellegaard argue that hygiene did not influence implant outcomes (success and bone loss) in the short term.²³ However, Lindquist et al. observed a higher bone loss in patients with poor oral hygiene.⁵ The influence of hygiene on the success of implants placed after direct sinus lift has been more rarely studied. Kan et al.¹¹ evaluated oral hygiene according to the modified plaque index as described by Mombelli et al.²¹ and reported a failure rate of 1.4% in patients with good oral hygiene, 13.9% with fair hygiene and 60% with poor oral hygiene; the differences between the groups were statistically significant.¹¹ In our study, a lower implant success rate was found in patients with poor hygiene (81.8%), compared with patients with regular and good hygiene (92.3% and 95.5%, respectively). The differences did not reach statistical significance, but the comparison between poor hygiene and the other two categories tended to significance ($p = 0.058$). In fact, a difference of over 10% with such a predictable treatment technique may be considered of clinical relevance, and the lack of statistical significance is probably related to the small number of patients with poor oral hygiene.

Conclusion

Within its limitations, the present investigation suggests that smoking and poor oral hygiene may negatively influence the outcome of implants placed both in one-stage and two-stage direct sinus lift procedures. However, the differences were in no case statistically significant, and prospective studies with larger sample sizes and longer follow-up are necessary to corroborate or refute these findings.

Competing interests

The authors declare that they have no conflict of interests related to this study.

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