



Management of the maxillary sinus complications after dental implantation: a systematic review and meta-analysis

Tratamento das complicações do seio maxilar após cirurgia de implante dentário: Revisão Sistemática e Meta-Análise

Samira JAMALI¹, Navid NASRABADI², Salar PAYAHOO³, Maryam DARVISH⁴, Hashem AHMADIZADEH⁵, Setareh KHOSRAVI⁶

1 - Department of Endodontics - Stomatological Hospital - College of Medicine - Xi'an Jiaotong University - Shaanxi 710004 - PR China.

2 - Department of Endodontics - School of Dentistry - Shahid Beheshti University of Medical Sciences - Tehran - Iran.

3 - Department of Oral and Maxillofacial Radiology - Dental School - Urmia University of Medical Sciences - Urmia - Iran.

4 - Department of Endodontics - School of Dentistry - Kerman University of Medical Sciences - Kerman - Iran.

5 - School of Dentistry - Tehran University of Medical Sciences - Tehran - Iran.

6 - Department of Orthodontics - Shahed University of Medical Sciences - Tehran - Iran.

ABSTRACT

Background and aim: Endoscopic sinus surgery owing to its satisfactory prognosis and low complication is considered as the first line of surgical procedure. Implant failure is often reported despite efforts in recent years. The purpose of this study was to review the factors leading to side effects in dental implantation of the maxillary sinus. **Material and Methods:** The systematic search was performed on electronic databases of MEDLINE, PubMed, Cochrane Library, Embase, ISI, Google scholar to find corresponding articles regarding dental literature during 2010 to 2019. Electronic title management was carried out by Endnote X9 software. Searches were based on the keywords of "dental implants", "Implants", "dental", "maxilla", "sinusitis". **Results:** The searched potentially relevant titles and abstracts were related to 294 articles, 104 of which were excluded due to lack of study inclusion criteria. At last, 11 articles were included into the final analysis. Postoperative sinusitis was found in 78 patients within 9 articles among 1195 patients. The implant failure was reported in 136 cases and the sinus membrane perforation in 185 sinuses within 11 articles among 1372 sinus lift procedures. **Conclusion:** The findings showed that the risk factors of sinusitis after implant surgery were Schneiderian membrane rupture and preoperative sinusitis, as well as smoking and residual bone height were the parameters elevating the dental implant failure risk.

KEYWORDS

Sinusitis; Dental implants; Implant failure.

RESUMO

Justificativa e objetivo: A cirurgia endoscópica do seio maxilar, devido ao seu prognóstico satisfatório e baixa complicação, é considerada a primeira opção cirúrgica. A falha do implante é frequentemente relatada, apesar dos esforços realizados nos últimos anos. O objetivo deste estudo foi revisar os fatores que levaram a efeitos colaterais no implante dentário do seio maxilar. **Material e Métodos:** A busca sistemática foi realizada nas bases de dados eletrônicas do MEDLINE, PubMed, Cochrane Library, Embase, ISI, Google Scholar para encontrar artigos correspondentes sobre literatura odontológica no período de 2010 a 2019. O gerenciamento eletrônico de títulos foi realizado pelo software Endnote X9. As pesquisas foram baseadas nas palavras-chave "implantes dentários", "implantes", "dentário", "maxila", "sinusite". **Resultados:** Os títulos e resumos potencialmente relevantes pesquisados foram relacionados a 294 artigos, 104 dos quais foram excluídos por falta de critérios de inclusão no estudo. Por fim, 11 artigos foram incluídos na análise final. Sinusite pós-operatória foi encontrada em 78 pacientes em 9 artigos entre 1195 pacientes. A falha do implante foi relatada em 136 casos e a perfuração da membrana sinusal em 185 seios, em 11 artigos, entre 1372 procedimentos de elevação sinusal. **Conclusão:** Os achados mostraram que os fatores de risco para sinusite após cirurgia de implante foram ruptura da membrana Schneideriana e sinusite pré-operatória, assim como tabagismo e altura óssea residual, os quais foram considerados parâmetros que elevaram o risco de falha do implante dentário.

PALAVRAS-CHAVE

Sinusite; Implantes dentários; Falha, implante.

INTRODUCTION

Dental implantation is globally fulfilled by various approaches along with the rapid advancement in the implantation technology [1]. The mandibular implants are stable support for maxillary implant insertion to be used as a solid base for implantation when maxillary thinning [2]. Prior to maxillary sinus implantation, it should be controlled by the elevation of maxillary sinus mucosa via the sinus lift procedure [3]. During the maxillary implants, the maxilla is thickened by bone grafts as bone transplantation in the presence of excessive maxillary pneumatization [4], thereby increasing the dental implant success rate [5]. The dental implant-induced chronic maxillary sinusitis can occur due to some reasons, such as oroantral fistula organization, postoperative ostial obliteration, the implant-stimulated sinus penetration, foreign body reaction-caused dental implant or bone graft dislocation, unwanted graft infection, preoperative chronic rhinosinusitis and Schneiderian membrane perforation. Endoscopic sinus surgery owing to its satisfactory prognosis and low complication is considered as the first line of surgical procedure [6]. Implant failure is often reported despite efforts in recent years. The purpose of this study was to review the factors leading to side effects in dental implantation of the maxillary sinus.

MATERIAL AND METHODS

The PRISMA statement was used to design and implement the current systematic review and meta-analysis. Systematic review of selected 11 articles was evaluated to draft the study protocol. The initial search results were recorded in a pre-prepared data extraction forms.

Search strategy

The systematic search was performed on electronic databases of MEDLINE, PubMed, Cochrane Library, Embase, ISI, Google scholar to find corresponding articles regarding dental literature during 2010 to 2019. Electronic title management was carried out by Endnote X9 software. Searches were based on the keywords of “dental implants”, “Implants”, “dental”, “maxilla”, “sinusitis”.

Study inclusion and exclusion criteria

The study inclusion criteria included:

1. Dichotomous data of articles properly reported on sinusitis before and after surgery
2. Dichotomous data of articles properly reported on implant failure before and after surgery
3. Dichotomous data of articles properly reported on sinus membrane perforation before and after surgery
4. Data of articles properly reported on sinusitis and dental implants
5. All language

The study exclusion criteria included:

1. Case reports or case series
2. Review articles
3. Articles containing questionnaire data
4. Correct target contents with no data reporting
5. Studies related to animal experiments

Extraction of data and method of analysis

The required data were extracted according to author names, study design, observation period, publication year, number of procedures, patients, sinusitis, dental implant failures and Follow-up. Random effects model was used for data analysis and calculation of summarized ORs with 95% confidence interval (95%CI) and considering inter- and intra-study variance. Comprehensive Meta-Analysis Stata V14 software was performed to analyze heterogeneity (I²) of RCTs, meta-analysis (weighted mean difference 95%CI) and forest plots.

RESULT

The searched potentially relevant titles and abstracts were related to 294 articles. In the first selection phase, 81 articles were excluded due to irrelevance of titles and abstracts. In the second selection phase, the full-text of remaining 213 articles was reviewed. Totally, 104 articles were excluded due to lack of study inclusion criteria. At last, 11 articles were included into the final analysis (Figure 1). Individual studies enrolled in this meta-analysis are shown in Table I.

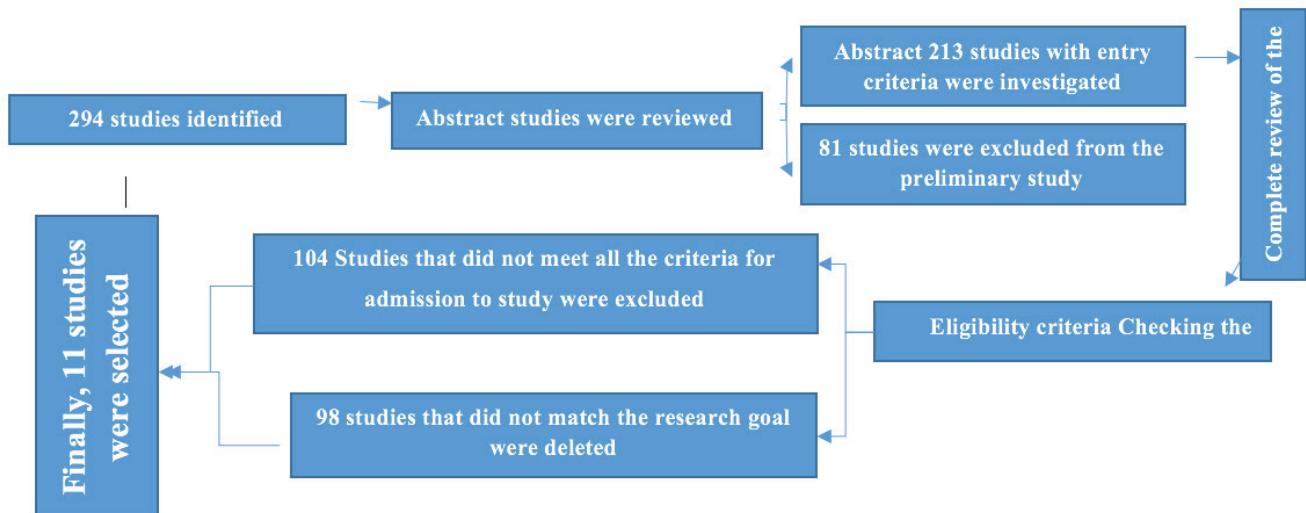


Figure 1 - Flowchart for the study selection.

Table I - Demographics of individual studies in this meta-analysis

Authors	Methodology	Duration of Follow-up, Month	Total No. of Patients	Sinusitis	Perforation of Sinus Membrane	Total No. of Sinuses	Implant Failure	Total No. of Implants
Chen et al[6], 2018	Prospective cohort study	36	84	6	6	NA	0	NA
Kozuma et al[7], 2017	Observational study	60	109	NA	18	121	8	252
Chirila et al[8], 2016	Retrospective study	36	116	5	1	151	5	245
Guerrero et al[9], 2015	Retrospective study	NA	68	NA	13	101	16	141
Vazquez et al[10], 2014	Retrospective study	108	127	6	52	202	9	364
Soardi et al[11], 2013	Retrospective study	216	256	0	3	323	19	376
Borges et al[12], 2011	Prospective study	12	15	2	2	30	1	53
Kim et al[13], 2013	Retrospective study	72	259	33	90	338	69	643
Kim et al[14], 2014	Retrospective study	48	60	5	17	65	9	65
Nolan et al[15], 2014	Retrospective stud	48	208	20	150	359	24	359
Kim et al[16], 2012	Prospective study	NA	70	1	2	70	0	70

Postoperative sinusitis was found in 78 patients within 9 articles among 1195 patients (Figure 2). The sinus membrane perforation was reported in 185 sinuses (Figure 3) and the implant failure in 136 cases (Figure 4) within 11 articles among 1372 sinus lift procedures.

In conditions affecting postoperative sinusitis, 2 studies with sample size of 323 were related to preoperative sinusitis (Figure 5A), 4

studies with sample size of 644 were related to intraoperative Schneiderian membrane perforation (Figure 5B), 2 studies with sample size of 236 were related to smoking and diabetes mellitus (Figure 5C and Figure 5E), 1 study with sample size of 109 was related to sex and co-existence of dental implant surgery (Figure 5D and Figure 5F).

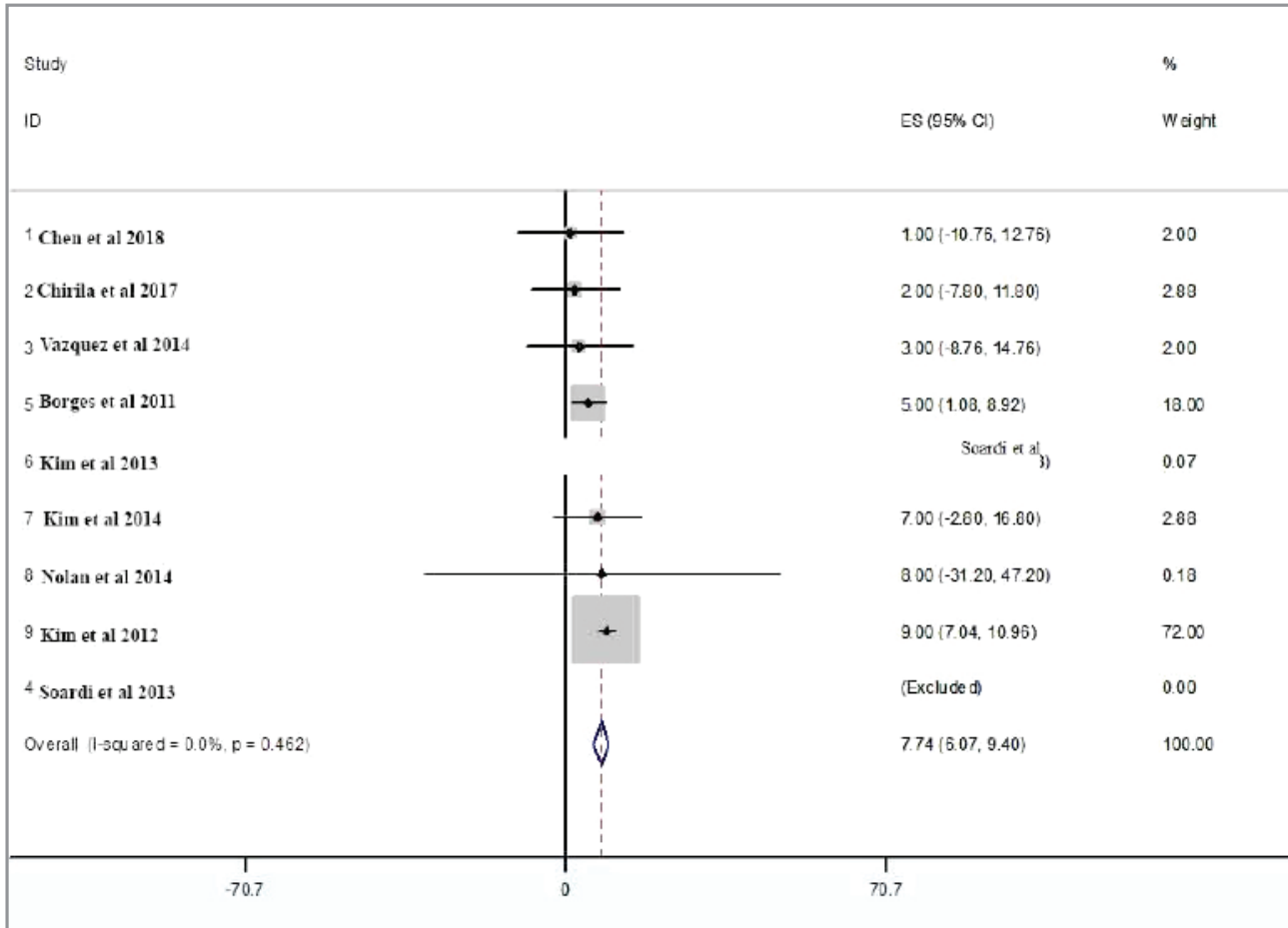


Figure 2 - Overall rates of postoperative sinusitis
 Heterogeneity chi-squared = 6.69 (d.f. = 7) p = 0.462
 I-squared (variation in ES attributable to heterogeneity) = 0.0%
 Test of ES=0 : z = 9.12 p = 0.000.

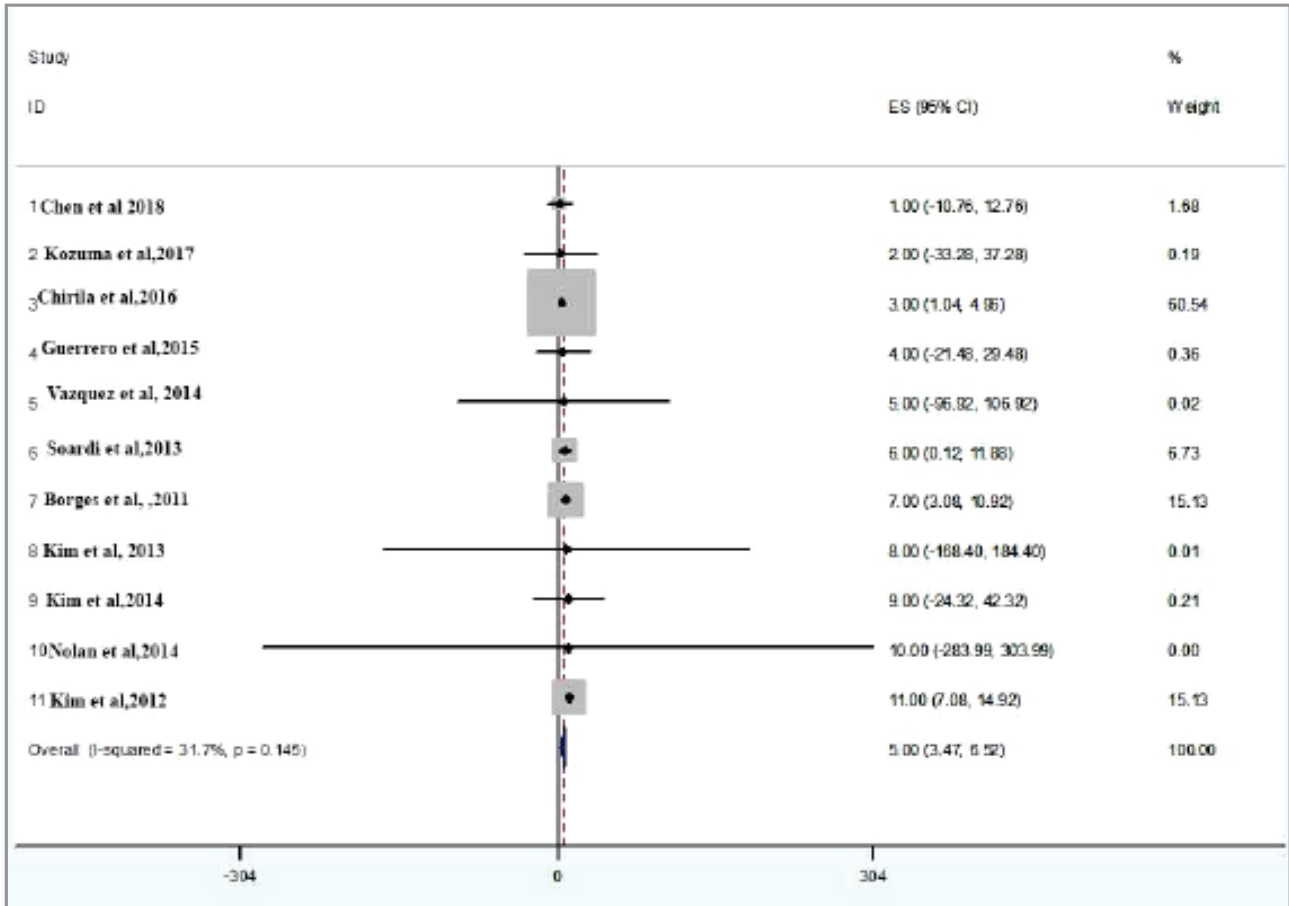


Figure 3 - Perforation of the Schneiderian membrane
 Heterogeneity chi-squared = 14.65 (d.f. = 10) p = 0.145
 I-squared (variation in ES attributable to heterogeneity) = 31.7%
 Test of ES=0 : z= 6.43 p = 0.000

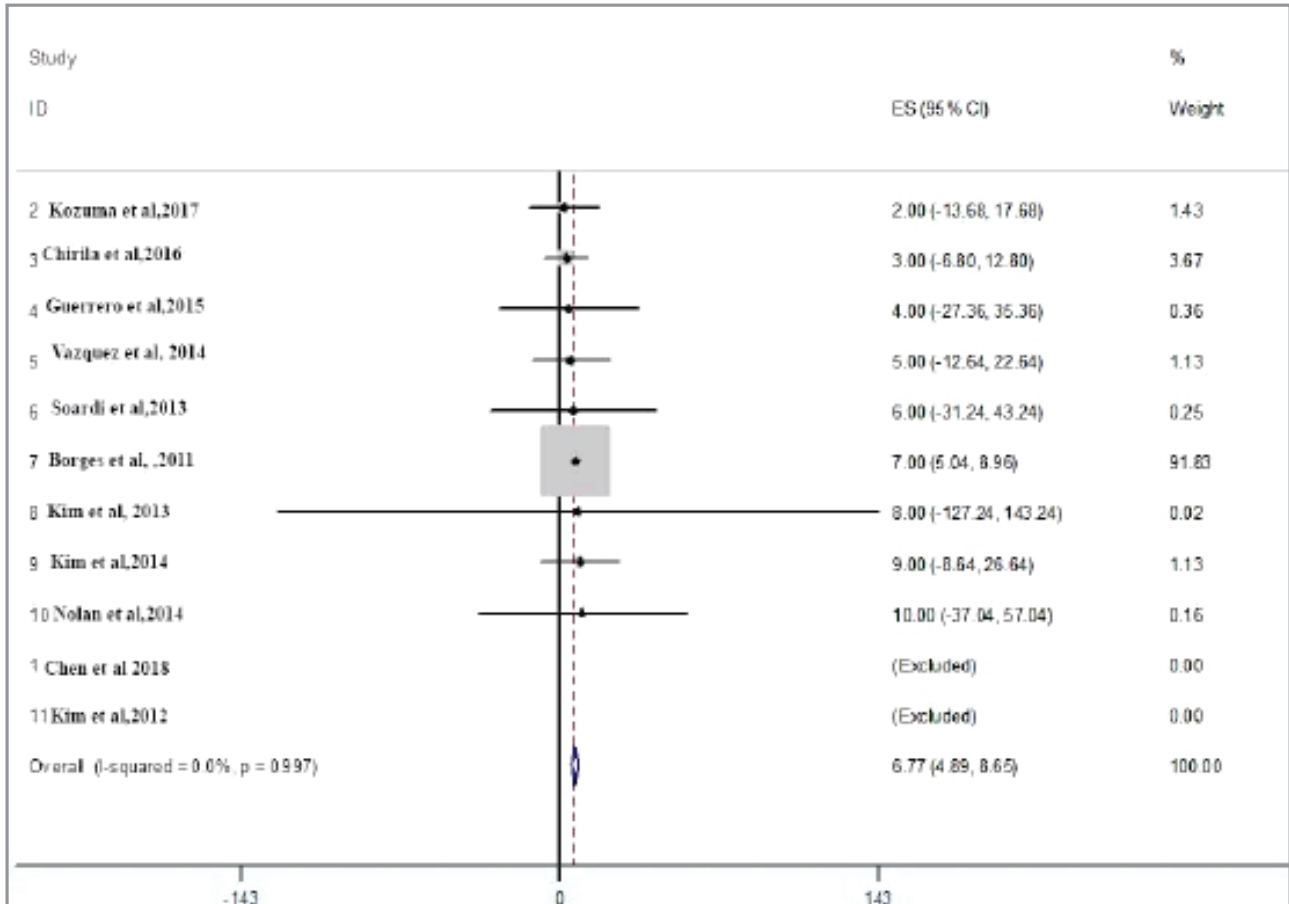


Figure 4 - Perforation of the failure of dental implant.
 Heterogeneity chi-squared = 1.13 (d.f. = 8) p = 0.997
 I-squared (variation in ES attributable to heterogeneity) = 0.0%
 Test of ES=0 : z= 7.07 p = 0.000

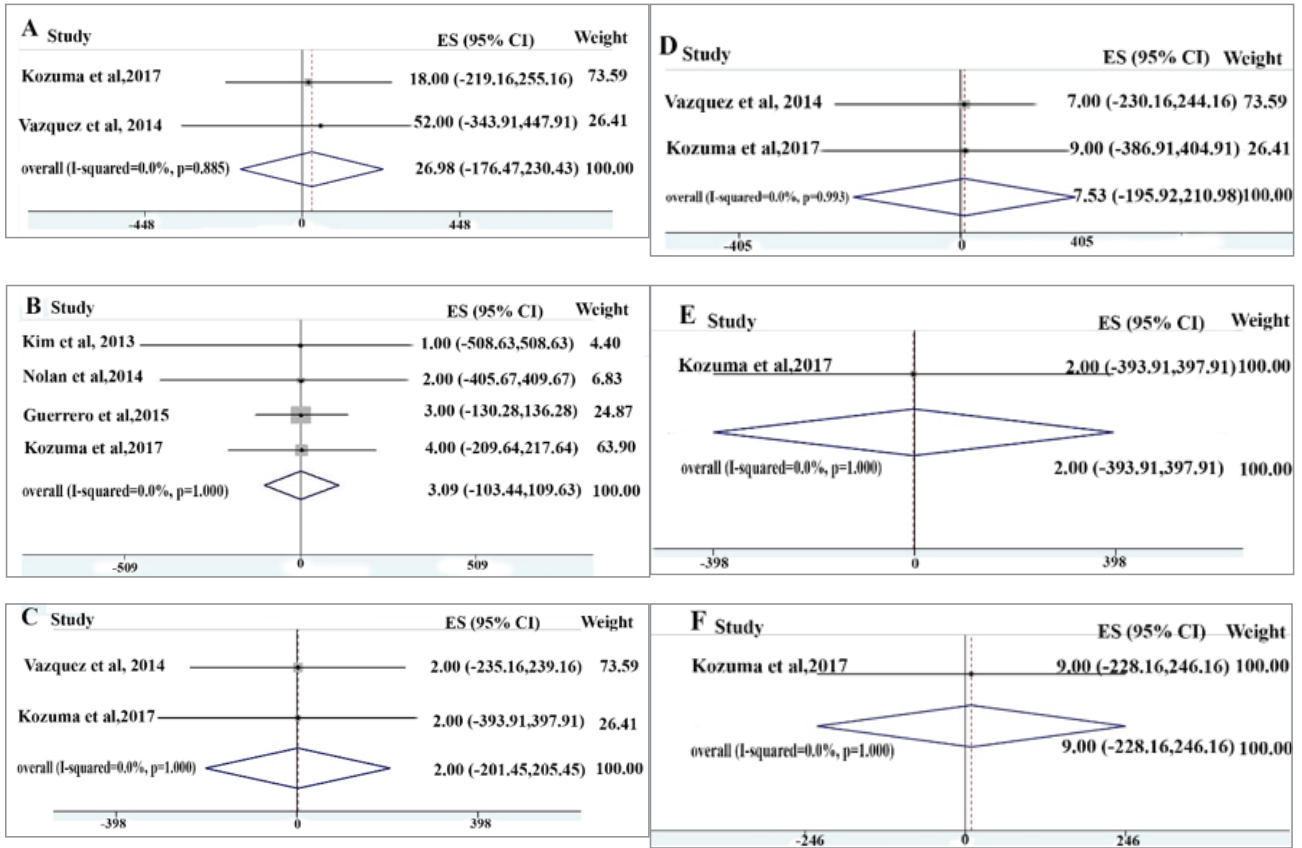


Figure 5 - Forest plots showing the relationship between postoperative sinusitis and each of the following primary outcomes: A: preoperative sinusitis, B: perforation of the Schneiderian membrane, C: smoker, D: diabetes mellitus, E: sex, F: simultaneity of dental implant surgery.

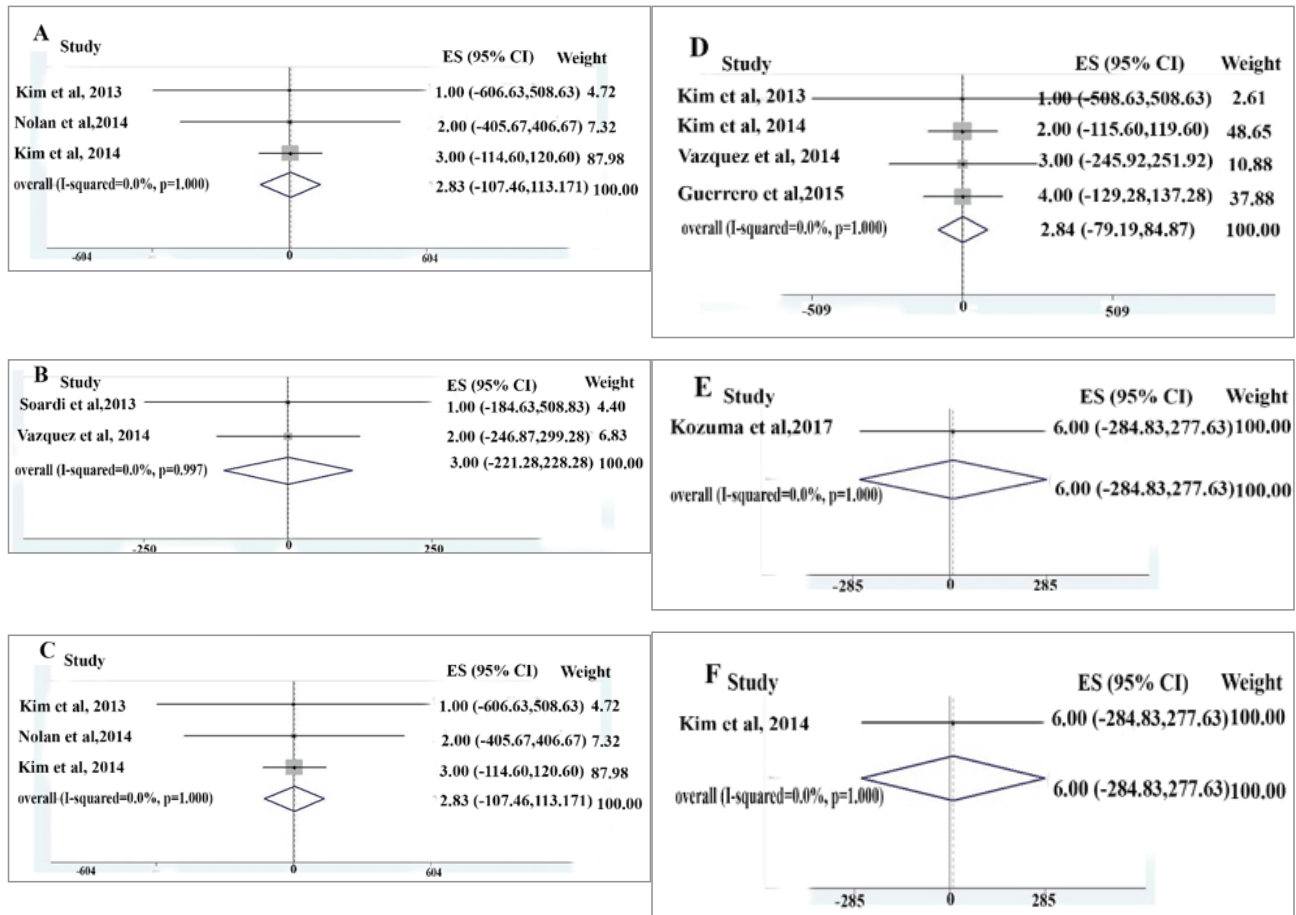


Figure 6 - Forest plots showing the relationship between dental implant and each of the following primary outcomes: A: perforation of the Schneiderian membrane, B: smoker, C: sex, D: dental implant surgery, E: surgical approach for dental implantation, F: age.

3 studies with sample size of 527 were related to intraoperative Schneiderian membrane perforation (Figure 6A), 2 studies with sample size of 383 were related to smoking (Figure 6B), 3 studies with sample size of 527 were related to sex (Figure 6C), 4 studies with sample size of 595 were related to co-existence of dental implant surgery (Figure 6D), 1 study with sample size of 109 was related to surgical procedure (Figure 6E), and other study with sample size of 60 were related to age (Figure 6F).

The postoperative sinusitis was affected only by intraoperative Schneiderian membrane perforation and preoperative sinusitis, but not by gender and smoking. The dental implant failure was affected only by maxillary residual bone height and smoking.

DISCUSSION

According to the findings from our analysis, the total incidence rate of postoperative sinusitis was estimated at 3%, and the total incidence rate of dental implant failure was 5%. It should be noted that the presence or absence of postoperative sinusitis was shown to be significantly influenced by the preoperative sinusitis. Moreover, the total incidence rate of sinus membrane perforation was calculated to be 17%. Our results revealed that the risk of sinusitis was reduced significantly in the absence of Schneiderian membrane perforation. The smoking may not significantly trigger sinusitis, but many inflammatory responses like marginal bone loss and peri-implantitis may develop the implant failure [10]. The smoking can reportedly

slow down the wound healing probably due to implant failure, in line with our findings [17]

Implant loss and postoperative infection can occur in the presence of sinus augmentation via a lateral open approach because of preoperative chronic sinusitis [18].

In a study of Fabbro et al., the survival rate of dental implants co-inserted by sinus augmentation cannot be influenced by preoperative maxillary sinus pathology [18] such as mucosal thickening (61.4%) found in 35 patients [19]. An otolaryngologist should deal with the elimination of adverse effects, such as rhinosinusitis, after dental implantation and the consideration of preventative actions prior to the implantation [20]. Pignataro et al. recommended three stages for a successful otolaryngologist while performing the sinus lift procedure, including preventative diagnosis, preventative therapy and diagnostic therapy [20].

The maxillary sinus develops postoperative hematoma or edema, hereby resulting in natural maxillary sinus ostial blocking and thus developing the sinusitis [7]. In accordance with the reports of Chen et al. [6], the medical therapy can sufficiently used to treat the chronic change-free sinusitis, in line with the present findings. Reportedly, the smoking interferes with leukocyte phagocytic adherence and chemotaxis as well as elevates the level of cytokines like interleukin. However, no definitive conclusions are available regarding the decreasing or increasing effect of smoking on postoperative sinusitis during dental implantation [10, 21-23].

CONCLUSION

The findings showed that the risk factors of sinusitis after implant surgery were Schneiderian membrane rupture and preoperative sinusitis, as well as smoking and residual bone height were the parameters elevating the dental implant failure risk.

REFERENCES

1. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JP, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *PLoS Med*. 2009 Jul 21;6(7):e1000100. doi: 10.1371/journal.pmed.1000100. Epub 2009 Jul 21.
2. Westover LM. Evaluation of the interface mechanical properties of craniofacial implants and natural teeth through development of the Advanced System for Implant Stability Testing (ASIST) [Thesis]. University of Alberta; 2016.
3. López-Quiles J, Melero-Alarcón C, Cano-Duran J, Sánchez-Martínez-Sauceda E, Ortega R. Maxillary sinus balloon lifting and deferred implantation of 50 osseointegrated implants: a prospective, observational, non-controlled study. *Int J Oral Maxillofac Surg*. 2018 Oct;47(10):1343-1349. doi: 10.1016/j.ijom.2018.04.014. Epub 2018 May 24.
4. Aghaloo TL, Misch C, Iacono VJ, Wang H-L. Bone Augmentation of the Edentulous Maxilla for Implant Placement: A Systematic Review. *Int J Oral Maxillofac Implants*. 2016;31 Suppl:s19-30. doi: 10.11607/jomi.16suppl.g1.
5. Chrcanovic BR, Kisch J, Albrektsson T, Wennerberg A. Survival of dental implants placed in sites of previously failed implants. *Clin Oral Implants Res*. 2017 Nov;28(11):1348-1353. doi: 10.1111/clr.12992. Epub 2016 Oct 14.
6. Chen YW, Lee FY, Chang PH, Huang CC, Fu CH, Huang CC, et al. A paradigm for evaluation and management of the maxillary sinus before dental implantation. *Laryngoscope*. 2018 Jun;128(6):1261-1267. doi: 10.1002/lary.26856. Epub 2017 Sep 16.
7. Kozuma A, Sasaki M, Seki K, Toyoshima T, Nakano H, Mori Y. Preoperative chronic sinusitis as significant cause of postoperative infection and implant loss after sinus augmentation from a lateral approach. *Oral Maxillofac Surg*. 2017 Jun;21(2):193-200. doi: 10.1007/s10006-017-0611-8. Epub 2017 Mar 22.
8. Chirilă L, Rotaru C, Filipov I, Săndulescu M. Management of acute maxillary sinusitis after sinus bone grafting procedures with simultaneous dental implants placement—a retrospective study. *BMC Infect Dis*. 2016 Mar 8;16 Suppl 1:94. doi: 10.1186/s12879-016-1398-1.
9. Guerrero JS. Lateral window sinus augmentation: Complications and outcomes of 101 consecutive procedures. *Implant Dent*. 2015 Jun;24(3):354-61. doi: 10.1097/ID.0000000000000250.
10. Vazquez JCM, de Rivera ASG, Gil HS, Mifsut RS. Complication rate in 200 consecutive sinus lift procedures: guidelines for prevention and treatment. *J Oral Maxillofac Surg*. 2014 May;72(5):892-901. doi: 10.1016/j.joms.2013.11.023. Epub 2013 Dec 2.
11. Soardi E, Cosci F, Checchi V, Pellegrino G, Bozzoli P, Felice P. Radiographic analysis of a transalveolar sinus-lift technique: a multipractice retrospective study with a mean follow-up of 5 years. *J Periodontol*. 2013 Aug;84(8):1039-47. doi: 10.1902/jop.2011.100684.
12. Borges FL, Dias RO, Piattelli A, Onuma T, Gouveia Cardoso LA, Salomão M, et al. Simultaneous sinus membrane elevation and dental implant placement without bone graft: a 6 month follow up study. *J Periodontol*. 2011 Mar;82(3):403-12. doi: 10.1902/jop.2010.100343. Epub 2010 Nov 8.
13. Kim YK, Hwang JY, Yun PY. Relationship between prognosis of dental implants and maxillary sinusitis associated with the sinus elevation procedure. *Int J Oral Maxillofac Implants*. 2013 Jan-Feb;28(1):178-83. doi: 10.11607/jomi.2739.
14. Kim YK, Ahn KJ, Yun PY. A retrospective study on the prognosis of single implant placed at the sinus bone graft site. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2014 Aug;118(2):181-6. doi: 10.1016/j.oooo.2013.05.011. Epub 2013 Jul 6.

15. Nolan PJ, Freeman K, Kraut RA. Correlation between Schneiderian membrane perforation and sinus lift graft outcome: a retrospective evaluation of 359 augmented sinus. *J Oral Maxillofac Surg*. 2014 Jan;72(1):47-52. doi: 10.1016/j.joms.2013.07.020. Epub 2013 Sep 24.
16. Kim DY, Itoh Y, Kang TH. Evaluation of the Effectiveness of a Water Lift System in the Sinus Membrane Lifting Operation as a Sinus Surgical Instrument. *Clin Implant Dent Relat Res*. 2012 Aug;14(4):585-94. doi: 10.1111/j.1708-8208.2010.00292.x. Epub 2010 Jun 25.
17. Kim JS, Choi SM, Yoon JH, Lee EJ, Yoon J, Kwon SH, et al. What Affects Postoperative Sinusitis and Implant Failure after Dental Implant: A Meta-analysis. *Otolaryngol Head Neck Surg*. 2019 Jun;160(6):974-984. doi: 10.1177/0194599819829747. Epub 2019 Feb 19.
18. Manor Y, Mardinger O, Bietlitum I, Nashef A, Nissan J, Chaushu G. Late signs and symptoms of maxillary sinusitis after sinus augmentation. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2010 Jul;110(1):e1-4. doi: 10.1016/j.tripleo.2010.02.038.
19. Küçük Kurt S. Evaluation of the survival of implant placement simultaneously with sinus augmentation: relationship in maxillary sinus pathologies. *Oral Radiol*. 2019 Jul 12. doi: 10.1007/s11282-019-00399-w. [Epub ahead of print]
20. Pignataro L, Mantovani M, Torretta S, Felisati G, Sambataro G. ENT assessment in the integrated management of candidate for (maxillary) sinus lift. *Acta Otorhinolaryngol Ital*. 2008 Jun;28(3):110-9.
21. Huang CC, Wang CH, Fu CH, Huang CC, Chang PH, Chen YW, et al. Association between cigarette smoking and interleukin-17A expression in nasal tissues of patients with chronic rhinosinusitis and asthma. *Medicine (Baltimore)*. 2016 Nov;95(47):e5432.
22. Strzelak A, Ratajczak A, Adamiec A, Feleszko W. Tobacco smoke induces and alters immune responses in the lung triggering inflammation, allergy, asthma and other lung diseases: a mechanistic review. *Int J Environ Res Public Health*. 2018 May 21;15(5). pii: E1033. doi: 10.3390/ijerph15051033.
23. Christensen DN, Franks ZG, McCrary HC, Saleh AA, Chang EH. A systematic review of the association between cigarette smoke exposure and chronic rhinosinusitis. *Otolaryngol Head Neck Surg*. 2018 May;158(5):801-816. doi: 10.1177/0194599818757697. Epub 2018 Feb 20.

Samira Jamali
(Corresponding address)

Department of Endodontics, Stomatological Hospital, College of Medicine, Xi'an Jiaotong University, Shaanxi 710004, PR China
E-mail: samira.jamali90@yahoo.com

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