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PREVALENCE OF INTRAOPERATIVE COMPLICATIONS WITH OPEN SINUS LIFT AND UNDERWOOD SEPTA

Gahri D.[1], Huseynov N.A.[2], Ivanov S.S.[1], Ivanov S.Y.[1, 3]

[1] Patrice Lumumba Peoples' Friendship University of Russia, Moscow, Russian Federation
[2] Private Dental Clinic "Centre of Modern Dentistry", Moscow, Russian Federation
[3] First Moscow State Medical University named after I.M. Sechenov (Sechenov University), Moscow, Russian Federation

SUMMARY

The loss of maxillary masticatory teeth is associated with a decrease in both the height and width of the alveolar bone mass. In addition to the bone limits, implant placement to replace the missing tooth is complicated by the close proximity of the maxillary sinus floor. The above can negatively affect the success of the patient's surgical rehabilitation. The maxillary sinus lift (MS), or sinus lift, can optimize the procedure and the results of dental implantation. Maxillary sinus floor lift surgery is a procedure with predictable results and a low complication rate, with an expected success rate of over 90% in the long term. However, like any surgical procedure, a sinus lift comes with some complications. One of the most common complications is Schneider's membrane perforation, which occurs either for iatrogenic reasons related to improper surgical actions or due to anatomical features of a particular patient that may complicate the procedure. A particularly interesting fact is the association of the incidence of MS membrane perforation with individual patient anatomy, particularly the presence of frontal or sagittal bony septa. ***The purpose*** *of this study is to determine the relationship of the incidence of Schneider's membrane perforation during sinus lift surgery in patients with and without bony septa in the MS.* ***Materials and Methods.*** *The present study included 100 patients who underwent open sinus lift surgery with subsequent implant placement. The participants were divided into 2 groups after studying the data of preoperative CBCT: group 1 – patients without septum in the MS (control group – 30 patients), group 2 – patients with septum in the MS (experimental group – 70 patients). Postoperative follow-up of the patients of both groups to monitor the presence of complications from Schneider's membrane was performed on the 3rd,5th,7th day according to clinical symptoms.* ***Results.*** *For group 1 patients (MS without septum), the rate of Schneider's membrane perforation during sinus lift was 20%, whereas for group 2 patients (MS with septum), the rate of perforation was 77.2%.* ***Conclusions.*** *The obtained data indicate a higher incidence of Schneider membrane damage during open sinus lift surgery in patients with individual anatomical features of the MS compared to patients with classic MS anatomy. The above-mentioned necessitates a more thorough preoperative planning of the invasive intervention, as well as a detailed analysis of 3D radiographs (CBCT) of the maxillary sinus.*

KEYWORDS: *sinus lift, perforation, CBCT, complications, implantation.*

CONFLICT OF INTEREST. The authors declare no conflict of interest.

РАСПРОСТРАНЕННОСТЬ ВНУТРИОПЕРАЦИОННЫХ ОСЛОЖНЕНИЙ ПРИ ОТКРЫТОМ СИНУС–ЛИФТИНГЕ И НАЛИЧИЕМ ПЕРЕГОРОДОК АНДЕРВУДА

Гахри Д.[1], Гусейнов Н.А.[2], Иванов С.С.[1], Иванов С.Ю.[1, 3]

[1] ФГАОУ ВО Российский университет дружбы народов имени Патриса Лумумбы, Москва, Российская Федерация
[2] Частная стоматологическая клиника «Центр Современной Стоматологии», Москва, Российская Федерация
[3] ФГАОУ ВО Первый МГМУ им. И.М. Сеченова Минздрава России (Сеченовский Университет), Москва, Российская Федерация

РЕЗЮМЕ

Потеря жевательных зубов верхней челюсти сопряжена со снижением как высоты, так и ширины костного массива альвеолярного отростка. Помимо костных лимитов, постановка имплантата для замещения отсутствующего зуба осложняется близким расположением дна гайморовой пазухи. Вышесказанное способно негативно повлиять на успех хирургической реабилитации пациента. Операция по подъему дна верхнечелюстной пазухи (ВЧП), другими словами, синус-лифтинг, способна оптимизировать процедуру и результаты дентальной имплантации. Операция по подъёму дна верхнечелюстной пазухи — процедура с предсказуе-

мыми результатами и низкой частотой осложнений, ожидаемый процент успеха которой составляет более 90% в долгосрочной перспективе. Однако, как и любое хирургическое вмешательство, синус-лифтинг сопряжен с некоторыми осложнениями. Одним из наиболее часто встречающихся осложнений является перфорация мембраны Шнайдера, возникающая либо по ятрогенным причинам, связанным с неправильными хирургическими действиями, либо из-за анатомических особенностей конкретного пациента, которые могут затруднить процедуру. Особенно интересным фактом является связь частоты перфорации мембраны ВЧП с индивидуальной анатомией пациента, в частности, наличием фронтальных или сагиттальных костных перегородок. ***Целью*** *данного исследования является определение взаимосвязи частоты перфорации мембраны Шнайдера в ходе операции синус-лифтинг у пациентов с костными перегородками в ВЧП и без них.* ***Материалы и методы.*** *В настоящее исследование были включены 100 пациентов, которым проводилась операция открытый синус-лифтинг с последующей установкой имплантата. Участники были разделены на 2 группы после исследования данных предоперационной КЛКТ: 1 группа – пациенты без перегородки в ВЧП (контрольная группа – 30 пациентов), 2 группа – пациенты с перегородкой в ВЧП (экспериментальная группа – 70 пациентов). Послеоперационное наблюдение за пациентами обеих групп для контроля наличия осложнений со стороны мембраны Шнайдера проводилось на 3, 5, 7 сутки по клинической симптоматике.* ***Результаты.*** *Для пациентов 1 группы (ВЧП без перегородки) частота перфорации мембраны Шнайдера в ходе синус-лифтинга составила 20%, в то время как для пациентов 2 группы (ВЧП с перегородкой) частота перфораций составила 77,2%.* ***Выводы.*** *Полученные данные свидетельствуют о более частом повреждении шнайдеровой мембраны в ходе операции открытый синус-лифтинг у пациентов с индивидуальными анатомическими особенностями ВЧП, по сравнению с пациентами классической анатомией ВЧП. Вышеобозначенное диктует необходимость более тщательного предоперационного планирования хода инвазивного вмешательства, а также детального анализа 3Д-рентгенограмм (КЛКТ) верхнечелюстной пазухи.*

КЛЮЧЕВЫЕ СЛОВА: синус-лифтинг, перфорация, КЛКТ, осложнения, имплантация.

КОНФЛИКТ ИНТЕРЕСОВ. *Авторы заявляют об отсутствии конфликта интересов.*

Introduction

Currently, implantation is considered a routine dental surgical procedure with few complications and predictable prospective results [1,2]. However, in some cases, it is possible to compromise the procedure of implant placement by anatomical limitations of bone tissue, especially with the close location of the floor of the maxillary sinus (MS). In cases of prolonged absence of teeth due to their removal, a decrease in the residual alveolar process and progressive pneumatization of MS is one of the most important factors affecting the support, fixation, stability and chewing function of the implant [3, 4, 5].

Accordingly, with prolonged absence of teeth in the lateral part of the upper jaw, both vertical and horizontal volumes of the alveolar process decrease, and the bottom of the MS becomes easily accessible for injury with surgical instruments, which makes implantation an impossible task under specified conditions.

In order to increase the volume of bone tissue in the masticatory sections of the upper jaw for optimal positioning of the implant and minimize intraoperative risks, an operation is performed to raise the floor of the maxillary sinus (sinus lifting). Maxillary sinus floor lift surgery is a procedure with predictable results and a low complication rate, with an expected success rate of over 90% in the long term. However, like any surgical procedure, sinus lifting is associated with some complications [6–8].

The literature describes both general complications associated with surgery, such as swelling, hematoma formation, and specific ones – chronic rhinosinusitis, blockage of the mouth of the MS and others [1]. One of the most common intraoperative complications of sinus lifting, both open and buried, is perforation of the Schneider membrane, which occurs either for iatrogenic reasons related to improper surgical procedures, or due to anatomical features of a particular patient that may make it difficult to perform the procedure [9–12].

A particularly interesting fact is the relationship between the frequency of perforation of the MS membrane and the individual anatomy of the patient, in particular, the presence of transversal or sagittal bone septa. The septa, or septa of the maxillary sinus, are barriers of cortical bone that divide the floor of the maxillary sinus into several compartments called recesses/pockets. They are one of the most common anatomical variations found in the maxillary sinuses (28–58% according to various authors) [13, 14]. Dr. Underwood first described this anatomical formation in 1910, which is why it is sometimes called the Underwood septum. According to literature data, septa are often found in the projection area of the 1st and 2nd molars or between these teeth, which is one of the deep places of the maxillary sinus [9, 12–14].

When chewing teeth are removed, bone tissue is remodeled and the height of the bone of the alveolar process recedes, which determines the patient's need for an implant with a preliminary increase in bone volume. The septa may partially protrude from the walls of the maxillary sinus or lead to a complete separation of the sinus into smaller paranasal sinuses [15, 16]. Being part of the internal configuration of the sinus, the septa can interfere with the preparation of the surgical site, making it difficult to lift the Schneider membrane without perforating it.

The above dictates the need for a preoperative diagnosis of the presence of additional bone structures of the HPV for optimal planning of the position and formation of the lateral window during the sinus lifting procedure, as well as to minimize intraoperative complications of the operation, for example, perforation of the maxillary sinus membrane.

The purpose of this study was to determine the effect of anatomical features of the maxillary sinus, namely the bone septa, on the risks of perforation of the Schneider membrane during open sinus lifting surgery.

Materials and Methods

This study was conducted in a private clinic of surgical dentistry. All patients selected for the experiment were warned about the course of the work and informed about possible risks and adverse effects associated with this surgical intervention. Informed voluntary consent was obtained and signed by each participant in the study.

A single operator performed all open sinus lift operations. The operator unified his manipulations, using instruments and techniques that minimize possible intraoperative complications and increase the probability of successful completion of the operation.

In this work, 100 patients who required open sinus lift surgery for subsequent prosthodontic rehabilitation of partial secondary adentia in the area of tooth 1.6 were included. The following inclusion criteria were developed to select the participants:

1. Age 25–35;
2. Partial secondary adentia of tooth 1.6;
3. The bone height of the alveolar process in the area of the proposed surgical intervention is 3–4 mm;
4. Absence of organic and inflammatory pathologies of the maxillary sinus.

The criteria for non-inclusion were:

1. Age under 25 and over 35;
2. Presence of tooth 1.6 in the dental arch or previously performed implant-supported prosthesis of tooth 1.6;
3. Somatic diseases in the stage of decompensation;
4. Uncontrolled diabetes mellitus of any type;
5. Bone height of the alveolar process in the area of intended surgical intervention is more or less than 3 4 mm;
6. Presence of organic and inflammatory pathologies on the side of the maxillary sinus;
7. Pregnancy.

The main exclusion criterion was the patient's willingness to end participation in the experiment.

The participants selected for the study were divided into 2 groups after preoperative CBCT and its analysis:

Group 1: 70 patients with septum in the MS (experimental group);

Group 2: 30 patients without septum in the MS (control group).

Each of the patients underwent open sinus lift surgery according to the following protocol:

Application anaesthesia (DiSiLan, Russia), after double negative aspiration test – infiltration anaesthesia Sol. Ultracaini D-S 4.0% 1:200.000 – 5.1 ml (3 carpules), an incision of the gingival mucosa to the bone is made in the centre of the alveolar process of the maxilla in the projection of the missing tooth 1.6 and a vertical loosening incision distally. The mucosa-adcostal flap is peeled off. In the anterolateral wall of the maxillary sinus at the level of the missing tooth 1.6, an oval-shaped osteotomy is performed in the anterolateral wall of the maxillary sinus with a ball-shaped bur using a physiodispenser. The Schneider's membrane is peeled off, placed horizontally, thereby raising the level of the floor of the maxillary sinus. The formed space is filled with BioplastDent 1g biomaterial and overlapped with BioplastDent 25×25 membrane. The flap is placed in place. The wound is sutured without tension with Vicryl 5-0 knotted sutures. Achieving haemostasis. Long-term planning of implantation 6–8 months after the intervention.

An ANOVA test was performed using StatPlus 6 software (AnalystSoft, CA, USA) for the mean data obtained in each study group. Data were also analysed using Fisher's exact test to assess the correlation of MS perforations with the presence of bony septa within the sinus ($p < 0.05$).

Results and Discussion.

Two groups of patients were compared for analysis: with and without bony septum in the maxillary sinus. The main variables are summarized in Table 1.

Table 1

Analyses comparing patients with and without bony septum in the maxillary sinus

Parameter	Group with septum (n=70)	Group without septum (n=30)	P-value
Average age (years)	39,9 ± 4,9	38,6 ± 4,8	>0,05[1]
Time of missing teeth in the target area (months)	30,7 ± 10,1	32,3 ± 8,1	>0,05[1]
Residual bone height (mm)	3 (2,75;4)	3 (3;4)	>0,05[2]
Gender (male/female)	42/28	16/14	>0,05[3]
Smoking/non-smoking	34/36	13/17	>0,05[3]

[1] – T-student's test, [2] – Mann – Whitney test, [3] – Fisher's exact test

In the group with septum, the mean age was 39.9±4.9 years, which was almost the same as in the group without septum (38.6±4.8 years). The differences did not reach statistical significance ($p > 0.05$).

The mean time of missing teeth was similar between the groups: 30.7±10.1 months in the group with septum and 32.3±8.1 months in the group without septum. These differences were also not significant ($p > 0.05$).

The median height of the residual bone was 3 mm in both groups. Interquartile ranges of 2.75 and 4 for the group with septum and 3 and 4 for the group without septum indicated no significant differences ($p > 0.05$).

More males were observed in the group with septum (42 males and 28 females), while the sex ratio was almost equal in the group without septum (16 males and 14 females). However, the differences were not significant ($p > 0.05$).

The proportion of smoking and nonsmoking patients was comparable between the groups. There were 34 smokers and 36 nonsmokers in the group with partition, whereas in the group without partition these figures were 13 and 17, respectively. The differences did not reach statistical significance ($p > 0.05$).

Comparison of baseline characteristics of patients in both groups revealed no statistically significant differences in any of the analysed parameters. This indicates the similarity of the groups, which allows us to consider them as homogeneous for further analysis of complications and treatment results.

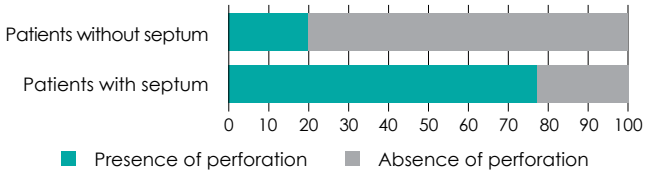

Fig. 1. Comparison of the presence of septal perforation in the two groups, %

The study analyzed the results of sinus lift in patients with and without septum in the maxillary sinus in terms of the frequency of Schneider's membrane perforation. 100 patients were included in the study and divided into two groups: with septum (70 patients) and without septum (30 patients).

A group with a partition, 54 patients (77.2%) showed perforation of Schneider's membrane, whereas 16 patients (22.8%) had no perforation.

A group without a partition, of the 30 patients in this group, 6 patients (20%) showed perforation of Schneider's membrane, while 24 patients (80%) had no perforation (Figure 1).

Data analysis using Fisher's exact test revealed statistically significant differences between groups in the incidence of Schneider's membrane perforation ($p < 0.05$. The odds ratio for the occurrence of perforation was OR = 13.5 (95% CI: 4.7–38.7), indicating a 13.5-fold increased risk of perforation in the group with septum (Table 2). Perforations were significantly more frequent in the group with septum than in the group without septum. This result suggests that the presence of a septum in the maxillary sinus is a risk factor for membrane perforation during sinus lift surgery.

Table 2

Odds ratio for the occurrence of perforation in patients with the presence and absence of a bone septum in the maxillary sinus

	Membrane perforation (n)	No perforation (n)	p	OR
Patients with bone septum (n=70)	54	16	<0,05[1]	13,5
Patients with no bone septum (n=30)	6	24		

[1] – point Fisher's criterion.

In studying the factors that influence the risk of Schneider's membrane perforation during a sinus lift procedure, the relationship between the height of the residual bone and the perforation rate was assessed, and the combined effect of the height of the residual bone and the presence of a septum on the complication rate was analysed.

To study the direct relationship between the height of the residual bone and the presence of membrane perforation, the correlation coefficient φ and Cramer's V were calculated. The coefficient values were $\varphi = -0.208$ and $V = 0.208$ ($p = 0.037$), indicating a weak feedback relationship (Figure 2). These results suggest that as the height of the residual bone increases, the probability of membrane perforation decreases slightly. However, the strength of the association remains low, limiting the possibility of using bone height as the sole predictor.

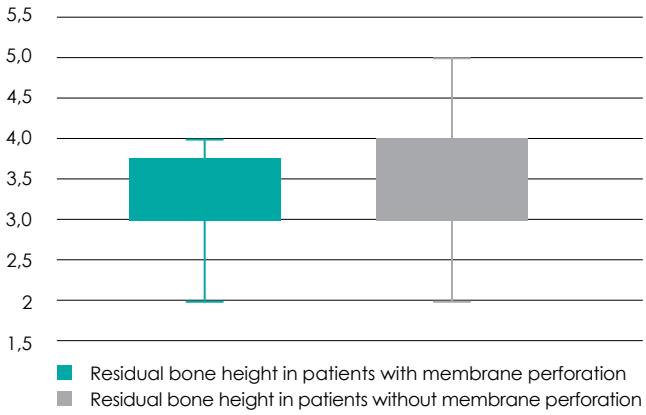

Fig. 2. Relationship between the height of the residual bone and the presence of membrane perforation, mm

A binary logistic regression model was constructed to assess the combined effect of residual bone height and septal presence. The results showed that residual bone height was not a significant predictor of perforation rate ($B = -0.204$), ($p = 0.393$) despite an 18.4% decrease in the odds of perforation ($Exp(B) = 0.816$) with each additional millimetre of height. This may indicate the influence of other factors that offset the role of bone height when an additional variable, the presence of a septum, is included in the model.

The presence of septum was the key factor that significantly increased the risk of membrane perforation ($B = 2.600$), ($p < 0.001$); $Exp(B) = 13.469$. This means that in the presence of a septum, the likelihood of complication increases more than 13-fold. This result emphasizes the need to consider the anatomical features of the maxillary sinus when planning a sinus lift procedure.

The difference between correlation analysis and regression model results can be explained by the interaction effect between variables as well as the influence of group factor. In direct correlation analysis, bone height shows a weak inverse relationship with perforation. However, in pooled estimation, the interaction with the presence of septum leads to a decrease in the statistical significance of bone height. This indicates a dominant role of septum in determining the risk of complications.

One of the possible postoperative complications of sinus lift is migration of bone material into the maxillary sinus, which is sometimes accompanied by the development of sinusitis. Analysing the frequency of these complications depending on the presence of a septum in the maxillary sinus, the following results can be noted:

1. Group with presence of septum (n=70):
   - Five patients (7.1%) had cases of material migration into the sinus with or without sinusitis.
   - There were no complications in 65 patients (92.9%).
2. Group without septum (n=30):
   - No cases of material migration or sinusitis have been reported.

Fisher's exact test was used to statistically evaluate the differences between the groups. The results of the analysis showed that there were no statistically significant differences in the frequency of these complications between the groups ($p > 0.05$) (Table 3).

Table 3

Migration of bone material into the sinus and development of sinusitis

	Was (n)	None (n)	p-value
Patients with bone septum (n=70)	5	65	>0,05[1]
Patients with no bone septum (n=30)	0	30	

[1] – point Fisher's criterion.

The findings suggest that the presence of a septum in the maxillary sinus is not a statistically significant factor that increases the risk of bone migration and sinusitis.

The results of this study emphasise the complexity of the relationships between anatomical factors that influence the risk of complications in sinus lift surgery. More detailed analyses with other factors, such as surgeon experience, surgical technique and soft tissue status, are required to further clarify the mechanism of bone height and septal height interaction.

Conclusion

Residual bone height has a weak inverse association with the risk of membrane perforation, but its value as a predictor decreases when the septum variable is included. The presence of maxillary sinus septum remains a key factor that significantly increases the risk of complications. This emphasises the need for careful preoperative diagnosis and individualisation of treatment.

The findings support the need for more thorough preoperative assessment of the anatomical features of the maxillary sinus and caution when performing the sinus lift procedure in patients with septum, which may reduce the risk of complications.

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INFORMATION ABOUT THE AUTHORS

Gahri Daniyal, *resident, Department of Oral and Maxillofacial Surgery and Surgical Dentistry, Federal State Educational Institution of Higher Education "Patrice Lumumba Peoples' Friendship University of Russia", Moscow, Russian Federation. E-mail: ghahridaniyal@gmail.com. Tel.: +79015916869. ORCID: 0000-0001-8515-6781. SPIN-code: 7564-5929. AuthorID: 1194375*

Huseynov Nijat Aydin oglu, *Candidate of Medical Sciences, doctor, dental surgeon, private dental clinic "Centre of Modern Dentistry". E-mail: nod.gus@mail.ru. Tel:. 89256147946. ORCID: 0000-0001-7160-2023. AuthorID: 1058819*

Ivanov Sergey Sergeyevich, *Candidate of Medical Sciences, Assistant of the Department of Oral and Maxillofacial Surgery and Surgical Dentistry, Federal State Educational Institution of Higher Education "Patrice Lumumba Peoples' Friendship University of Russia", Moscow, Federation. E-mail: ivan-swim@yandex.ru. Tel.: +79169705145. SPIN-code: 5056-0721. AuthorID: 1073711*

Ivanov Sergey Yurievich, *MD, Professor, Corresponding Member of the Russian Academy of Sciences, Head of the Department of Oral and Maxillofacial Surgery and Surgical Dentistry, "Patrice Lumumba Peoples' Friendship University of Russia", Moscow, Russian Federation; Head of the Department of Oral and Maxillofacial Surgery, First Moscow State Medical University named after I.M. Sechenov (Sechenov University), Moscow, Russian Federation. E-mail: syivanov@yandex.ru. Tel.: +79057572424. ORCID 0000-00015458-0192. SPIN-code: 2607-2679. AuthorID: 615227*