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Management of Ruptured Sinus Membrane in Maxillary Sinus Lift Surgery: a Systematic Literature Review

Manejo da Membrana Sinusal Rompida em Cirurgias de Levantamento de Seio Maxilar: uma Revisão Sistemática

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Abstract

Schneiderian membrane rupture is a common intraoperative complication during maxillary sinus surgery. The objective of this study was to verify the methods of conduct during rupture of the sinus membrane in maxillary sinus surgeries that offer the best clinical results. Google Scholar and PubMed (MEDLINE) databases were searched from April 2020 to May 2023 for articles published between 2016 and May 2023 with descriptors selected from DeCs/MeSH "cone-beam computed tomography", "maxillary sinus", "sinus floor augmentation" and "intraoperative complications". This systematic review was carried out based on PRISMA methodology and registered in PROSPERO. The quality of the included studies was assessed using the MINORS index. The search term combinations resulted in a total of 724 titles. Altogether four studies met the inclusion criteria with 330 patients requiring graft in the posterior maxillary region with residual bone height <5 mm. The studies included 394 sinus lifting surgeries with access through the side window. A total of 114 cases of sinus membrane perforation (28.93%) were included with 88 cases (77.19%) successfully identified, 7 (6.14%) reporting failures in graft integration, and 19 cases (16.67%) of drilling were not rated for success/failure. Among the methods most cited for sinus membrane rupture, the membrane suture technique, collagen membranes, platelet rich fibrin, or not repairing the perforation were successful. Despite the success rates associated with various therapeutic modalities for rupture of the sinus membrane, no consensus in the literature exists regarding the technique offering the best result.

Keywords: Cone-beam Computed Tomography. Intraoperative Complications. Maxillary Sinus. Sinus Floor Augmentation.

Resumo

A ruptura da membrana sinusal é uma ocorrência transoperatória comum durante a cirurgia de levantamento do assoalho do seio maxilar. O objetivo do presente estudo foi verificar os métodos de conduta durante a ruptura da membrana sinusal que oferecem os melhores resultados clínicos. As bases de dados Google Scholar e PubMed (MEDLINE) foram pesquisadas de abril a junho de 2023 para artigos publicados entre 2016 e abril de 2023 com os termos "cone-beam computed tomography", "maxillary sinus", "sinus floor augmentation" e "intraoperative complications". Esta revisão sistemática foi realizada de acordo com a metodologia PRISMA e sob registro da PROSPERO. A qualidade dos estudos foi avaliada pelo índice MINORS. As combinações dos termos de pesquisa resultaram em 724 títulos. Quatro estudos preencheram os critérios de inclusão com 330 pacientes que necessitaram de enxerto na região posterior de maxila com altura óssea residual <5 mm. Os estudos contemplaram 394 cirurgias de levantamento de seio via janela lateral. Um total de 114 casos de perfuração da membrana sinusal (28,93%) foram incluídos, com 88 casos (77,19%) identificados como sucesso, 7 casos (6,14%) relatando falhas na integração do enxerto e 19 casos (16,67%) de perfuração não foram avaliados quanto ao sucesso/fracasso. Dentre os métodos mais citados para manejo da ruptura de membrana sinusal, a sutura da membrana, membranas de colágeno, fibrina rica em plaquetas ou não reparo da perfuração foram bem-sucedidas. Apesar do sucesso associado às modalidades terapêuticas para ruptura da membrana sinusal, não existe consenso na literatura sobre a técnica com melhor resultado.

Palavras-chave: Tomografia Computadorizada de Feixe Cônico. Seio Maxilar. Levantamento do Assoalho do Seio Maxilar. Complicações Intraoperatórias.

1 Introduction

The successful oral rehabilitation of edentulous areas is possible through implantology. However, the placement of implants in the posterior maxilla is challenging due to low bone density and atrophy, in addition to the pneumatization of the maxillary sinus resulting from tooth loss.[1] In these situations, surgical procedures such as the maxillary sinus lift, should be carried out prior to the implant placement, to enable the posterior maxillary rehabilitation[1,2].

The maxillary sinus is defined as an air space occupying most of the maxilla with an average height of 33 mm and its volume, membrane, and inherent characteristics, as well as its relationship with other anatomical structures such as the nasal cavity have been extensively studied.[1,2] Pathologies like rhinosinusitis and anatomical variations such as asymmetry, hypoplasia, presence of sinus septum, pneumatization, and exostoses may be present in the maxillary sinus.[1-3] Thus, there is susceptibility to the risk of sinus membrane perforation

during the surgical approach with the possibility of failed implant osseointegration, in addition to limitations in the implants placement and/or surgical corrections for gaining bone tissue for rehabilitation.

For lifting the maxillary sinus floor, two main surgical approaches are available, access through the side window and the crestal approach.[4] Thus, preoperative evaluation using computed tomography is essential for diagnosis and proper planning of surgery avoiding complications, such as perforation of the Schneiderian membrane.[5-8]

Perforation of Schneiderian membrane may occur more frequently in patients with sinusitis prior to surgical intervention, with a marked risk of other intraoperative complications such as bleeding, leakage of cystic fluid or purulent exudate, and displacement of the graft to the maxillary sinus.[6] Despite the risks related to ruptured membrane, Park et al.[6] stated that injuries without repair did not influence the long-term clinical and radiographic outcomes after maxillary sinus lift surgery. However, Tukel & Tatli[8] claimed perforation of the sinus membrane having a negative effect on the graft success post-surgically.

The objective of this study was to conduct a systematic review to verify the therapeutic methods offering the best resolution in the sinus membrane rupture cases in maxillary sinus surgeries.

2 Material and Methods

2.1 Eligibility criteria and search strategies

This study used the preferred report items for systematic reviews and meta-analyzes (PRISMA) statement, which sought retrospective articles of cohort studies, cross-sectional study and control case. The question which was assessed was "What are the therapeutic methods indicated in cases of rupture of the sinus membrane during maxillary sinus lifting with access to the side window for implant rehabilitation?" The anagram PICO (representative acronym Patient, Intervention, Comparison and Outcomes) was used, where the population was represented by the patients who underwent lateral window maxillary sinus lift with rupture of the sinus membrane, the intervention consisted of the therapeutic methods indicated for ruptured sinus membrane, the controls were represented by the non-intervention in cases of rupture of sinus membrane, and the expected outcome was the integration of the bone graft for rehabilitation with implants. This revision was registered in the PROSPERO (International Registry of Systematic Reviews) with number CRD42020197828, published on August 11th, 2020.

For identifying the studies, the electronic databases Google Scholar and PubMed (MEDLINE) were searched from April 2020 to May 2023. For this, the DeCs/MeSH descriptors used were "cone-beam computed tomography", "maxillary sinus", "sinus floor augmentation", and "intraoperative complications", combined using the Boolean expression "AND". Two examiners read the titles and abstracts studies without being blinded for the names of the authors, journals, or publication date. A manual search was concluded with a review of the references of the selected articles to identify additional studies important for the discussion of the results.

2.2 Inclusion and exclusion criteria

The selected articles were evaluated according to the inclusion criteria including the availability of the full text, the language (English), the types of studies (randomized clinical trials, prospective cohort studies, and cross-sectional study), sample size of patients, and the publication period (between 2016 and May 2023). The exclusion criteria included studies involving patients with congenital diseases, such as cleft lip and palate, and maxillofacial trauma affecting the maxillary sinus. In *vitro* studies, experimental animal studies, systematic reviews, and case reports were also excluded.

2.3 Article selection, data extraction and methodological quality

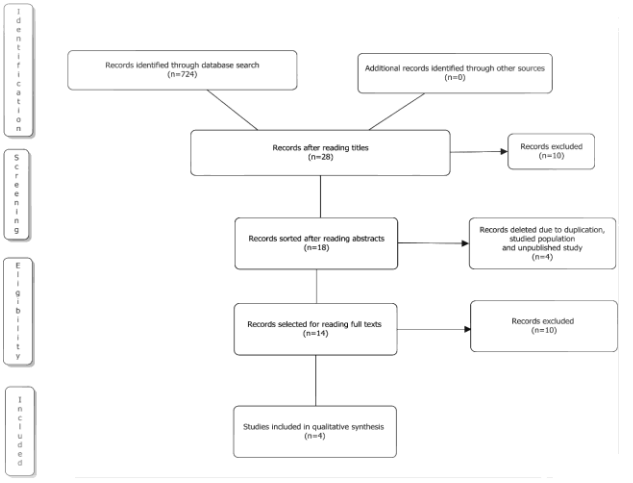
The articles selected according to the inclusion and exclusion criteria were independently assessed by the two reviewers IOBF and ACSF. Any disagreements between the reviewing authors were resolved by consensus or by consulting the last signing author of the study - ACSF. The level of agreement between the two reviewing authors was assessed using the Cohen kappa statistic which showed a result of 0.89, with concordance classified as almost perfect. The data from the included studies were extracted independently by the two reviewers, by searching for the following variables for each study: type of study, studied population, methodology, results, and the outcomes. A third reviewer was consulted in the event of any disagreement. Data extraction using the inclusion and exclusion criteria was carried out according to the ethical aspects, clear methodology, and presence of results. Duplicate articles were considered only once. A descriptive analysis of the studies was conducted. Two authors independently evaluated the quality of the studies included in the systematic review using the methodological index for non-randomized studies (MINORS)[9]. The MINORS scale includes the following points: (a) a clearly stated aim; (b) inclusion of consecutive patients; (c) prospective collection of data; (d) appropriate endpoints; (e) unbiased assessment; (f) a follow-up period; (g) losses to follow-up of <5%; and (h) prospective calculation of the study size. The items on the MINORS scale are scored as 0 (not reported), 1 (reported but inadequate), or 2 (reported and adequate). The quality of each included study was defined from the total score as poor (<5), fair (6–10), or good (>11). The level of agreement between the two reviewing authors regarding the risk of bias in the studies was assessed using the Cohen kappa statistic which showed a result of 0.90.

3 Results and Dicussion

The use of search terms resulted in a list of 724 studies published between 2016 and May 2023. After reading the titles, a total of 28 studies were selected, 4 published in PubMed and the remaining 24 in Gooogle Scholar. After reading the abstracts and defining the types of studies, 18 retrospective studies were assessed for eligibility. Following this, two duplicate studies, one randomized cadaveric study and another unpublished study were excluded, resulting in 14 publications selected for reading the full text and analyzing the other inclusion criteria. After reading the full text, a study was excluded due to the surgical technique of transcrestal access

used to access the maxillary sinus membrane. The complete reading and the consequent analysis of the exclusion criteria allowed the selection of four studies meeting all the inclusion criteria (Figure 1).

Figure 1 - Prisma® flowchart of the search and search results



Source: research data.

Two independent reviewers assessed the quality of the four studies included using the MINORS scale, with good methodological quality with an assessment of 12 points (Table 1). The information of each study is summarized in Table 2. The four studies including 330 patients with the requirement of graft in the posterior maxillary region with residual bone height less than 5 mm were registered.

Table 1 - Quality assessment scores using the methodological index for non-randomized studies (MINORS). Scale: 0 (not reported), 1 (reported but inadequate) or 2 (reported and appropriate). The quality of each included study was defined from the total score as poor (<5), fair (6-10) or good (> 11)

Study	Clear aim (a)	Inclusion of consecutive patients(b)	Prospective collection of data(c)	Appropriate endpoints(d)	Unbiased assessment(e)	Follow-up period(f)	Losses to follow-up <5% (g)	Prospective calculation of study size (h)	Total score	Study quality
Park et al.[6]	2	2	2	2	0	2	2	0	12	Good
Barbu et al.[7]	2	2	2	2	0	2	2	0	12	Good
Oncu, Kaymaz[10]	2	2	2	2	0	2	2	0	12	Good
Marin et al.[11]	2	2	2	2	0	2	2	0	12	Good

Source: research data.

Table 2 - Data of selected articles according to inclusion and exclusion criteria

Title/ Author	Type of Study	Sample	Metodology	Results	Outcome
The clinical and radiographic outcomes of Schneiderian membrane perforation without repair in sinus elevation surgery. Park et al.[b]	Retrospective	Patients who had residual bone height of less than 5 mm in the posterior region of the maxilla (n = 63) in need of graft and rehabilitation with implants.	65 sinus lift surgeries through the side window access using a spherical drill performed from July 2014 to January 2017. The thickness of the Schneiderian membrane and the amount of residual bone were measured using the CFFC. In case of perforation, no attempt was made to repair the membrane.	The perforation rate of the sinus membrane was 39%. There was a significant association between the presence of sinusitis before surgery and the occurrence of perforation of the Schneiderian membrane (P = 0.03), which was significantly thicker in patients with perforation than in those without perforation (P <0.001). There was no implant failure in any of the groups, despite the identification of major intra and postoperative complications in the group with perforation without repair.	Perforation of the membrane without repair did not adversely affect clinical and radiographic results. There was no implant failure during the follow-up period.

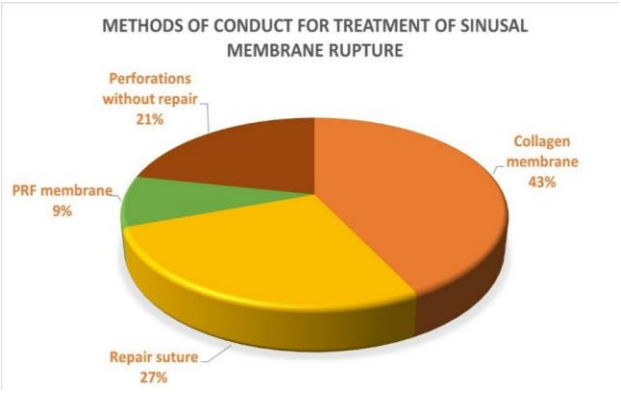
Management of Schneiderian Membrane Perforations during Sinus Augmentation Procedures: A Preliminary Comparison of Two Different Approaches. Barbu et al.[7]	Retrospective cohort	Patients with residual bone height of less than 5 mm in the posterior maxilla (n=130)	Surgeries with piezoelectric through the side window access. Analysis of 02 surgical techniques (suture of the membrane or use of collagen membrane - CopiOs Pericardium Membrane) for the 61 membrane perforations (35% of 172 sinus lift surgeries) reported, 45 of which were ruptures due to accidental membrane injury and 16 (26%) during incision to remove mucocele pseudocysts.	Of the 31 cases treated with sinus membrane repair technique with suture, 26 (84%) were successful, with graft integration. Failures occurred in the other 05 cases (16%). Of the 30 perforations treated with low resorption collagen membranes, 28 (93%) had successful graft integration, while 02 (7%) failed.	Therapeutic success in 88.52% of cases of sinus membrane repair. The suture of the Schneiderian membrane can be a skillful and less expensive alternative.
Assessment of the effectiveness of platelet rich fibrin in the treatment of Schneiderian membrane perforation Oncu, Kaymaz[10]	Retrospective (Control case)	16 patients (10 men and 6 women) were included in this study with residual bone height <4mm in the posterior region of the maxilla. Patients underwent sinus lift through the side window access performed between 2014 and 2016.	Evaluation of the effect of treatment with PRF in cases of perforation of the maxillary sinus membrane and evaluation of the influence on bone formation, new vascular supply and success rate of survival of dental implants. Twenty maxillary sinuses with piezoelectric were approached (10 sinuses repaired with PRF; and 10 sinuses without membrane perforation).	The perforations - resulting from the use of manual instruments for lifting the sinus membrane - were treated with PRF membranes. This was followed by the xenogenous graft (Apatos, Osteobiol) and collagen membrane (Osteobiol) for closing the side window. In both groups (without perforation and with perforation), it was observed that vasculogenesis was possibly increased. The implant survival rates in both groups were 100% and no bone loss around the implants was observed. There was an apparent increase in alveolar bone height in the CFFCs.	PRF can be considered an alternative material for repairing sinus membrane perforations, being easy to handle, totally autogenous, in addition to having anti-inflammatory properties. As limitations of the study, the number of cases was cited and there was no histological evaluation with a color different from the newly formed bone.

Potential risk factors for maxillary sinus membrane perforation and treatment outcome analysis. Marin et al.[11]	Retrospective	Patients who underwent sinus floor lifting in the Division of Oral Surgery and Orthodontics - Medical University of Graz from 2013 to 2017 (n = 121)	137 sinus floor augmentation surgeries accessed through the side window using a handpiece with stainless steel drills. The authors proposed to evaluate the potential risk factors for membrane perforation and to analyze the therapeutic results with the use of collagen membrane (Bioguide).	There were 19 cases (13.9%) of perforation of the membrane up to 10 mm and were treated with the Bioguide membrane without complications during follow-up. Two statistically significant factors for perforation: contour of the maxillary sinus (P = 0.001) and thickness of the maxillary sinus membrane (P = 0.005). The rate of perforation was higher in narrow, tapered sinus and when the membrane was thinner than 1 mm.	The contours of the maxillary sinuses and the thickness of the sinus membrane seem to be relevant factors for the occurrence of perforations, successfully treated by the use of the collagen membrane.

Source: research data.

In total, 394 maxillary sinus lift surgeries with access through the side window were considered with 114 cases of sinus membrane perforation (28.93%). The results of the review showed the occurrence of 98 cases (85.96%) of accidental sinus membrane perforations and 16 (14.04%) of incision-related perforations to remove mucocele pseudocysts. The therapeutic methods adopted to repair the ruptured sinus membrane reported by the authors included membrane repair with suture in 31 cases (27.19%), the use of collagen membrane in 49 (42.98%), repair with the use of platelet rich fibrin (PRF) membrane in 10 cases (8.77%), and the spontaneous perforation repair in 24 cases (21.05%) as shown in Figure 2.

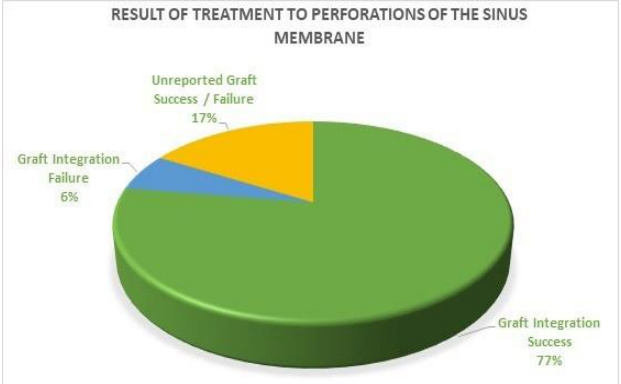
Figure 2 - Percentages on methods of conduct in cases of rupture of the sinus membrane



Source: research data.

It was evident that of the 114 cases of sinus membrane perforation, 88 (77.39%) were successfully identified, 7 (6.14%) reported failures in graft integration, and 19 cases (16.67%) of non-perforation were classified according to success/failure (Figure 3).

Figure 3 – Percentages of success/ failure of graft integration in the treatment of sinus membrane perforations



Source: research data.

Barbu et al.[7] reported the incidence of 26% accidental sinus membrane perforations in sinus lift surgeries. The authors treated perforation with suture or low resorption collagen membranes with 84% and 93% success in each technique employed, respectively. In a study by Marin et al.[11], the authors reported 19 cases (13.9%) of membrane perforations up to 10 mm in diameter treated with BioGuide

collagen membrane without complications during the follow-up period after at least 6 months.

Oncu and Kaymaz[10] analyzed the use of PRF in 10 maxillary sinuses to treat ruptured sinus membrane with diameter smaller than 10 mm. Perforations occurred during the use of manual instruments for lifting the sinus membrane and the PRF membranes were placed directly over the rupture. This was followed by the placement of the xenogenous graft (Apatos, Osteobiol) and a collagen membrane (Osteobiol) to close the side window without placement of an immediate implant. The authors reported 100% success in maxillary sinuses with ruptured membranes treated with PRF. The cases of membrane perforation, with no signs of infection, were surgically approached again after 6 to 8 months of the sinus lift surgery for the implant placement. The authors detected no bone loss around the implants in the follow-up period of 6 to 12 months.

Park et al.[6] evaluated the behavior of sinus membrane perforations without repair. The thickness of the Schneiderian membrane and the residual bone before surgery were evaluated using cone-beam computed tomography and, in cases of perforation (39% of a total of 65 maxillary sinuses), no attempt was made to repair the membrane. The perforation was examined and measured using a digital probe or depth gauge ranging from 3 to 30 mm diameter. The Prichard elevator was inserted into the sinus cavity to avoid displacement of the bone graft and then the alloplast graft was condensed only in the direction of the sinus floor. The side window was covered with or without resorbable membrane and the amount of bone graft was measured after surgery. The thickness of the Schneiderian membrane and the acquired bone height were recorded using the cone-beam computed tomography at the time of delivery of the prosthesis, six months after implant placement. The authors concluded that rupture of the Schneiderian membrane without repair did not adversely affect clinical and radiographic results.

This systematic review included four studies, comprising 394 maxillary sinus lift surgeries accessed through the side window. In 114 cases (28.93%) of sinus membrane perforation, the therapeutic approaches used were repair with membrane suture in 31 cases (27.19%), collagen membrane in 49 (42.98%), PRF membrane in 10 (8.77%), and the spontaneous perforation repair in 24 cases (21.05%). The result after management included 88 successful cases (77.19%); 7 cases (6.14%) reported failures in graft integration after repair of the sinus membrane with suture or with low resorption collagen membrane; and in 19 cases (16.67%) of perforation treated with Bioguide® collagen membrane from the study by Marin et al.[11] were not classified as to graft success/failure constituting a study limitation.

Marin et al.[11] reported the influence of sinus membrane perforation on the occurrence of postoperative complications (sinusitis, displacement of the graft within the sinus, difficulty healing, and inflammation) and bone graft failure. These data corroborate the findings of Schwarz et al.[12] and Oncu and Kaymaz.[10] However, the last authors highlighted other possible postoperative complications such as iatrogenic infections of the sinuses, edema, bleeding, loss of bone graft material, increased implant failure rate, and an interruption of normal sinus physiological function.

Park et al.[6] described some intraoperative complications during the management of ruptured sinus membrane including bleeding, leakage of cystic fluid or purulent exudate from sinus pathology, and displacement of the graft into the sinus cavity, corroborating with the results by Kim et al.[13] The most evident postoperative complications observed by Park et al.[6] in the sinus membrane perforation group were nasal bleeding and facial edema.

The maxillary sinus membrane consists of a columnar ciliated pseudo-stratified epithelium and a well-vascularized lamina propria in addition to microvessels.[10] The thickness of the sinus membrane is a potential risk factor for the occurrence of perforation during maxillary sinus surgeries.[6,11] In a retrospective study, Marin et al.[11] reported more frequent sinus membrane perforations in membranes of 0–1 mm (47.4%), followed by 1–2 mm (21.1%), and 2–3 mm (15.8%) thickness. The study by Park et al.[6] demonstrated that the Schneiderian membrane was significantly thicker (>2 mm on average) in patients with perforation compared to those without it ($p < 0.001$) and also possible significant association between sinusitis before surgery and the occurrence of ruptured Schneiderian membrane.

Marin et al.[11] pointed that the occurrence of a ruptured sinus membrane was statistically significant ($p = 0.001$), when the maxillary sinus contours were narrow and tapered, probably due to the difficulties in manipulation with surgical instruments and a narrow visual field. For cases with narrow conical sinus contours and a thin sinus membrane, a piezoelectric device may be recommended to access the side window. In addition, the authors mentioned no significant difference in the probability of perforation sinus membrane considering the sinus septa in the maxillary sinus intervention.

The results of this review demonstrated the occurrence of 98 cases (24.87%) of accidental ruptured sinus membrane considering 394 surgeries, with approximately 26% incidence as described by Barbu et al.[7] Oncu & Kaymaz[10] categorized sinus membrane perforations in classes 1 to 5. Class 1 perforation being less than 2 mm in diameter, does not require additional treatment. Perforation between 2 mm to 5 mm (class 2) can be repaired with the fold technique (folding the sinus membrane and inserting the bone graft material). In class 3 (perforation greater than 5 mm), the "membrane sandwich technique" is indicated. In classes 4 and 5, the perforations, although not described by the authors as to the difference between them, represent complications of extraction or failure to raise the sinus and following the execution of the "membrane sandwich technique", the treatment requires waiting for spontaneous healing for surgical access later. Oncu and Kaymaz[10] did not

describe the "membrane sandwich technique", the type of membrane used, or the time to wait for spontaneous healing.

However, a sandwich technique was described by Ritter et al.[14] using a collagen membrane to repair the perforation with bone graft (Bio-Oss, Geisltich, Switzerland) and reticulated collagen membrane (OssixPlus©, Datum Dental, Israel) to cover the side window. Ferreira et al.[15] indicated this technique for perforation repair through resorbable suture or a collagen membrane (CollaCote, Zimmer Dental), bone graft with Bio-Oss (Geisltich, Switzerland) and inserting another collagen membrane (BioGuide, Geisltich, Switzerland) to cover the side window corroborating the Von Arx et al.[16] technique with the exception of the double collagen membrane (BioGuide) used by these authors. However, Rapani et al.[17] indicated the membrane integrity inspection by the Valsalva maneuver, treating the perforations with resorbable collagen membrane (Lyoplant, B. Braun Aesculap AG, Germany), insertion of biomaterial (BioOss, Geistlich, Söhne, AG), and adaptation of the collagen membrane in the window. However, these studies lacked the standardization regarding the use of collagen membranes.

The data from the study by Ritter et al.[14] showed that the perforation of the sinus mucosa was inversely proportional to the mucosa thickening >2 mm assessed tomographically ($p = 0.011$). This was probably due to the association of other potential risk factors such as age, smoking, diabetes, use of drugs such as bisphosphonates, and recurrent procedures. The authors used the sinus membrane perforation repair technique successfully (98.5%) for integration of implants in 32 cases (22%) with rupture of the sinus mucosa observed during access through the side window, but the dimensions of the perforations were not mentioned. Ritter et al.[14] highlighted the occurrence of oroantral fistulas in two cases after six months of the maxillary sinus lifting procedure with membrane perforation culminating in the failure of the implant integration.

Oncu & Kaymaz[10] stated complete repair of perforations with a diameter between 2 mm and 15 mm using collagen membranes, fibrin membrane, regenerated oxidized cellulose, and bone graft. This is contrary to the maximum diameter (10 mm) with indication of repair reported by Marin et al.[11] and Lin et al.[18] In cases of larger diameters where repair is impossible, it is indicated to interrupt the graft surgery and wait for the regeneration of the membrane for a new surgical approach to lift the maxillary sinus. However, the authors did not describe the average time for reintervention.

Tukel & Tatli[8] reported the use of collagen membranes (Collagen AT, Padova, Italy) to repair perforations smaller than 5 mm and Kim et al.[13] discussed repair of perforated sinus membrane with the use of collagen membrane associated with fibrin patches with 100% implant survival, suggesting it to be a safe and predictable treatment.

In the Marin et al.[11] study, sinus membrane perforations up to 10 mm diameter were successfully treated, similar to the technique by Froum et al.[19], where using resorbable collagen membrane was effective in preventing postoperative complications. These date corroborate the indication of Kim et al.[13] for repairing sinus membrane perforation >5 mm or when in case of risk of the graft material spreading through perforation. However, Marin et al.[11] did not describe the percentage of success with the treatment instituted in sinus membrane perforation, and its association to postoperative complications or implant survival.

Oncu and Kaymaz[10], evaluated the influence of PRF on bone formation, the new vascular supply, and the survival of dental implants. The authors concluded that, in cases of membrane perforations smaller than 10 mm, PRF can be considered an alternative material for the repair of sinus perforations, as it is autogenous, easy to handle, with natural adhesive and potential anti-inflammatory properties. According to Choukroun et al.[20], PRF plays an important role on angiogenesis and immunological control with the use of circulating stem cells, in addition to wound protection by epithelial coverage, reinforcing the indication of this biological material for sinus membrane repair as described by Oncu and Kaymaz.[10]

Park et al.[6] evaluated how perforations of the sinus membrane during maxillary sinus lifting surgeries through the lateral window behaved without repair and concluded that the Schneiderian membrane perforation without repair did not adversely affect the clinical and radiographic results. This result suggests the excellent regenerative potential of the sinus membrane even without any repair, despite the variation in sizes (3 to 30 mm diameter) of the perforations, the risk of graft displacement to the sinus cavity, and/or postoperative infections.

The procedures of repair of membrane rupture occurring during maxillary sinus lift surgeries were successfully reported by the authors included in the systematic review, by using collagen membranes, suturing the sinus membrane, use of PRF, or by preservation without repair intervention. However, there is no consensus in the literature regarding the technique with better results as well as the size of the perforations indicated for repair.

4 Conclusion

In general, most of the studies showed good methodological quality. Some limitations were observed during the construction of this study. First, the limited number of articles included in this review. Also, heterogeneity between the types of studies that made meta-analysis impossible. Despite these limitations, it is strongly recommended to conduct new studies with other inclusion criteria to investigate a greater number of patients with a longer follow-up time with emphasis on other repair techniques different, if any, from those discussed in this review.

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