

# A Comparison of the Clinical Performance Between the Lateral Sinus Lifts and Percrestal Sinus Lifts in Severely Atrophied Posterior Maxilla

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**Abstracts:** Aim/Objective: The objective of our study is to compare the clinical performance between the lateral sinus lift and the percrestal sinus lift techniques in severely atrophied posterior maxilla. Materials and Methods: An electronic search was done by three independent reviewers using a computerized search involving multiple databases focusing on comparative articles discussing the differences between lateral sinus lift technique and percrestal sinus lift technique. The search involved a solid application of the authors' inclusion and exclusion criteria. Results: The combined search done by the authors identified 19 eligible articles. 13 of which were excluded strictly based on the inclusion and the exclusion criteria leaving us with 6 accepted articles to conduct this systemic review. 3 of the articles are clinical trials, 2 are retrospective studies and 1 is a prospective study. In all of the 6 selected articles, a comparative discussion between the lateral sinus lift technique and percrestal sinus lift technique was done. Conclusions: The lateral sinus lift technique has higher morbidity and success rates when compared to the percrestal sinus lift technique. However, that does not eliminate the fact that the latter is still a viable choice if a less invasive is necessary or if the alveolar height at baseline is not as diminished.

**Keywords:** Lateral Sinus Lift, Per Crestal Sinus Lift, Trans-Alveolar Sinus Lift, Maxillary Sinus Surgery, Atrophic Posterior Maxilla AND Sinus Lift, Maxillary Sinus Augmentation, Sinus Lift in Atrophic Maxilla, Clinical Performance of Maxillary Sinus Lift, And Direct Sinus Lift Versus Indirect Sinus Lift.

## 1. INTRODUCTION

Out of the four paranasal sinuses, the maxillary sinus is considered the largest of them. In adults, the maxillary sinus contains approximately 12-15 ml of air [1]. It is pyramidal in shape where the base is near the nasal cavity, the upper border forms the floor of the orbit, and the apex of the sinus is directed towards the zygomatic bone [2]. As for the floor of the sinus, it runs anteriorly to the Premolar or canine area and as far as the maxillary tuberosity posteriorly [3]. The maxillary sinus is located inside the maxillary bone [4]. The function of the sinus includes supplying some extent of warmth and humidification to inspired air, giving resonance to voice, as well as contributing to the shape of the face [5].

According to literature, the process sinus pneumatization could be proportional to the process of ageing, other factors that have the ability to impact the process are related to hereditary factors, craniofacial configuration, the density of bone, undergoing sinus surgeries, growth related hormones, the pressure of air within the sinus cavity and the pneumatization of the nasal mucous membrane itself [5, 7, 8, 9]. Furthermore, the maxillary sinus undergoes physiological growth as a person grows older, but the existence of teeth restrains the growth of the sinus. This is why, following an extraction of teeth in the maxilla, the sinus tends to expand inferiorly at the cost of the bone that surrounds it [7]. Bone resorption in the posterior maxilla is continuous because of the lack of stimuli brought out by occlusal forces. On the cellular level, the reduction in bone height is due to the continuous activity of

the osteoclasts [10]. The process of sinus pneumatization might sometimes be substantial, causing root exposure, leading to an engagement of the maxillary molar and premolar roots into the maxillary sinus floor. This leads to a reaction of complications when undergoing teeth extractions and causes implant placement difficulties [11, 12]. Nonetheless, with the resulting bone height decrease in the posterior maxilla and the accompanying process of sinus pneumatization, there are currently no studies that fully clarify the process of pneumatization [13].

The need for compensating the edentulous atrophic posterior maxilla motivated the creation of a treatment option known as the sinus lifting procedure that will allow restoring the bone height and create room for implant placement [14, 15, 16]. Although there are many modifications to the different techniques of sinus lifts, the two main techniques for maxillary sinus augmentation remain the lateral sinus lift and the percrestal sinus lift. The first ever performed lateral sinus lift technique was by Tatum in 1975 [17]. The procedure depends mainly on opening a lateral window and lifting the Schneiderian membrane of the sinus through direct visualization of the surgical site. It was found that a vertical height of more than 9mm can be obtained through the lateral sinus lift technique. This is essential when there is severe bone loss [18]. The percrestal sinus lift technique was first performed in 1994 by Summers [19]. In this surgery the osteotomes are inserted through the extraction site and the Schneiderian membrane is indirectly manipulated and lifted. Almost 3-9mm of vertical bone height can be gained through the percrestal sinus lift technique [20, 21, 22, 23, 24].

## **2. OBJECTIVES**

The objective of our study is to compare the clinical performance between the lateral sinus lift and the percrestal sinus lift techniques in severely atrophied posterior maxilla. This systematic review encompasses everything from the success rates, morbidity rates, and the complications during and after each of the surgeries.

## **3. MATERIALS AND METHODS**

### **3.1. Focus Question**

According to the problem, intervention, comparison and outcome (PICO), we generated a focus question with respect to our systematic review which is: What is the difference between the clinical performance of lateral sinus lift technique and Percrestal sinus lift technique in severely atrophic posterior maxilla?

### **3.2. Search Strategy**

Our search strategy involved an electronic search which was performed by three independent reviewers (SA, TD and MS). Computerized search was conducted using multiple databases which were PubMed, Google Scholar, Scopus and Academia using the following search terms: lateral sinus lift, Per Crestal Sinus lift, Trans-alveolar sinus lift, Maxillary Sinus Surgery, Atrophic Posterior Maxilla AND sinus lift, Maxillary Sinus Augmentation, sinus lift in atrophic maxilla, clinical performance of maxillary sinus lift, and Direct sinus lift versus Indirect sinus lift.

### **3.3. Inclusion Criteria**

In our systematic review, we considered using Randomized clinical trials and retrospective human studies as well as prospective studies that were performed between the years 2001 and 2021.

Furthermore, we focused on including patients that are medically fit and who are partially edentulous and necessitate maxillary sinus elevation procedures. We chose articles that were not restricted to this region and in the English language.

### **3.4. Exclusion Criteria**

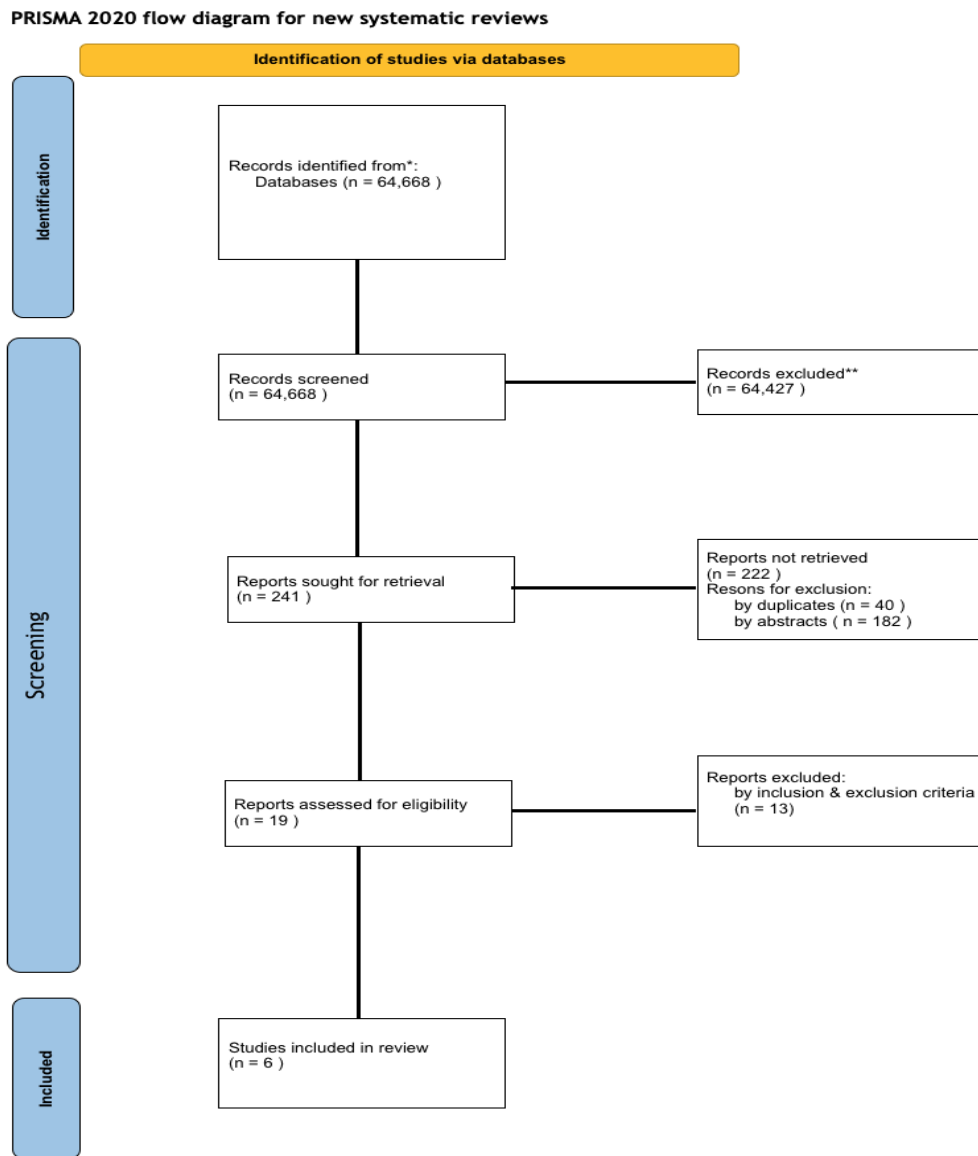
Our exclusion criteria are comprised of patients who have serious systemic illnesses and/or take drugs that might impact the success rate of any of the procedures, patients who are chronic smokers, patients with preexisting

maxillary sinus problems, and we excluded any animal studies, cross sectional studies, literature reviews and systematic reviews.

## 4. RESULTS

### 4.1 Sequential Data strategy

Following the search for literature using the above-mentioned databases, systematic reviews, meta-analysis, literature reviews, book chapters, and case reports were considered irrelevant to our research and therefore excluded by reading the titles of those articles. Further articles were excluded based on irrelevant abstracts. According to our inclusion and exclusions criteria found above, we excluded more articles after finding them unfit to our criteria in the last stage of article selection which involved reading full text articles. FIG 3. PRISMA FLOW CHART



### 3.5. Data Extraction

**Table 1. Data Extraction**

Author	Year of Publication	Type of the study	Sample size	Defect location	Test groups	Follow up period	Result/ findings	Outcome
1) U. S. Pal et al	2012	Randomized clinical trial	20 Patients	Posterior maxilla	Group A: Direct sinus lift Group B: Indirect Sinus lift	IOPA and OPG at the 1 <sup>st</sup> , 3 <sup>rd</sup> , 6 <sup>th</sup> and 12 <sup>th</sup> weeks	90% of group A and 70% of group B had gingival inflammation.  50% of group A and 30% of group B had swelling.  The average bone height gained was more in group A.	No difference in swelling, stability, pain or gingival status between the two sinus lift techniques.  Increase in bone height was more in the direct sinus lift procedure.
2) S.M. Balaji	2013	retrospective study	182 patients	Posterior maxilla	Group 1: Direct sinus lift. Group 2: Indirect sinus lift.	The patients were monitored on a periodic basis, both clinically and radiologically.	The increase in bone height for ISAT was 99.52% while for DSAT it was 177.22%  Indirect sinus lift presented a post-operative height of 13.22 mm.  The Direct sinus lift presented a post-operative height of 10.13 mm.	The use of these techniques: Direct and indirect sinus lift procedures provide cost affordable, less risky, as well as predictable results.
3) Farina	2018	Randomized	57	Posterior	Group 1: Transcrestal	Periapical x rays	Pain was less in the	In the lateral sinus lift there was less

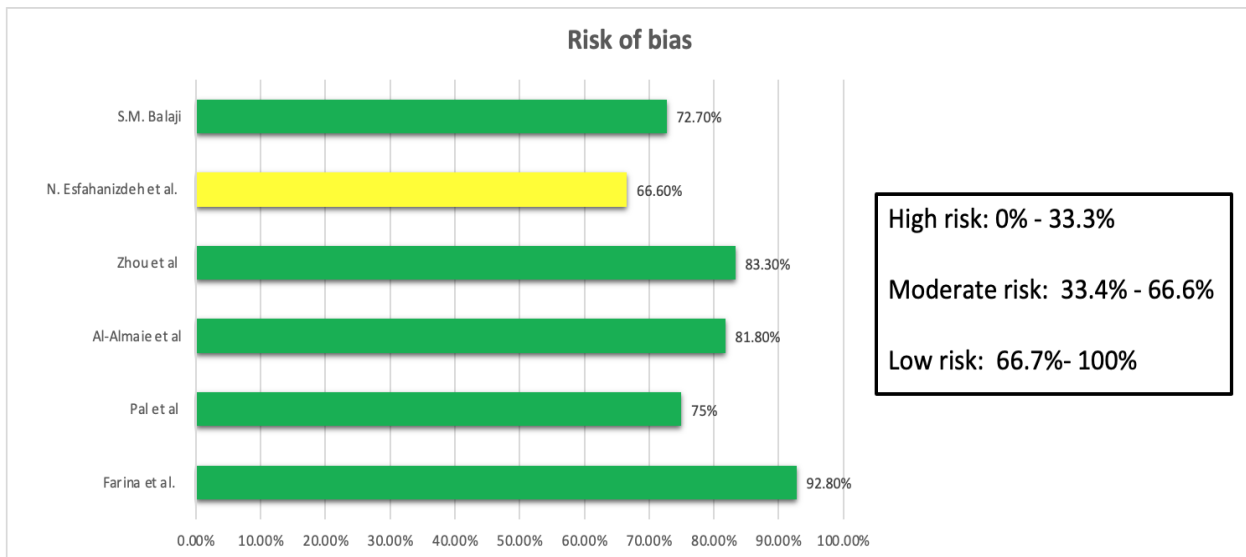
et al.		clinical trial	patients	Maxilla	sinus lift  Group 2: Lateral sinus lift.	were taken post operatively.	Transcrestal procedure in the first 2 weeks with less incidence of swelling and bruising.	pain on the day of surgery, and the Transcrestal sinus lift showed a lesser postoperative morbidity overall.
4) Saad Al-Almaie et al.	2017	Retrospective	10 patients	Posterior maxilla (bilateral)	All patients underwent both lateral and percrestal sinus lift techniques in a split mouth design	Conventional radiography and CT scans 36 months after the permanent prosthetic insertion	For pain, intra-oral and extra-oral swelling, and bruising; crestal approach was notably associated with less severity when compared to the lateral approach	This study concluded that when both techniques are performed on the same patient, they could be evaluated precisely
5) N. Esfahanizdeh et al.	2012	Clinical trial	10 patients	Posterior maxilla	First group: Lateral sinus lift technique  Second group: Osteotome technique	Clinical follow up at 10 months.	There were no post-surgical complications such as sinus infection or bleeding reported.	The osteotome technique is an alternative for the lateral sinus lift technique when there's anatomical variations and limited access for lateral window preparation.
6) Zhou et al	2020	Prospective study	36 patients	Posterior maxilla (unilateral and bilateral)	Group A: Lateral sinus floor elevation  Group B: Percrestal sinus floor elevation	Clinical and radiographical follow ups on the day of surgery and at the 6th, 12th, 18th, and 24th	No major differences were found in ESBG and ABH after surgery, but lateral sinus lift technique group presented higher values than percrestal sinus lift	The lateral sinus lift technique can obtain noticeably more ESBG as compared to percrestal sinus lift technique, but both surgeries are highly predictable for sites of RBH $\leq 6$ mm. An alternative to LSFE is the TSFE.

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**3.6 - Risk of bias and qualitative assessment**

The risk of bias and Quality assessment was based on the published full-text articles and was performed by investigators (SA, TD and MS) independently for the purpose of reducing bias. All the Randomized clinical trials as well as the retrospective and prospective studies were assessed using the NIH system checklist. In our systematic review, five of the studies chosen were categorized to fit into the good section and are regarded to have a low risk of bias. While one article was categorized as fair and therefore has a moderate risk of bias.

**Table 2. Risk of bias diagram.**



**4. Discussion**

This systematic review encompasses all the information that was deemed important by us in order to state the differences of the clinical performance between the Lateral sinus lift technique and the Percrestal sinus lift technique.

In the comparative clinical study done by [25] the lateral sinus lift technique group presented a greater number of patients who had pain as compared to Percrestal sinus lift technique group. Evaluating the pain levels of both groups, it was noted in this article, that the patients had a major reduction of pain as time passed by. This coincides with the retrospective study by [28] where it was revealed that the Percrestal sinus lift technique group experienced much less pain severity in comparison with the lateral sinus lift technique group. For both techniques, this is justified because of the elevation of soft tissue, bone drilling, pressure caused by implant insertion, cutting of bone and finally sinus floor elevation [25]. Some are due to manipulation of the facial flap and others to the manipulation of the sinus membrane [26]. Whereas the clinical trial by [27] states that the Lateral sinus lift technique showed lower pain levels on surgery day than the Percrestal sinus lift technique. Patients in the percrestal sinus lift technique group reported having severe discomfort concerning the tapping action of the osteotomes used in the surgery leading to a negative judgement of the Percrestal sinus lift surgery [26].

Another point mentioned is the Gingival status in which it was found that a higher number of patients in the lateral sinus lift technique group experienced mild gingival inflammation than in the precrestal sinus lift technique group. In the lateral sinus lift technique group, the gingival inflammation was eradicated at a later time than in the Percrestal sinus lift technique group, however, inflammation was found completely gone at later follow ups and gingival status was found stable in both groups. These facts were mentioned in the comparative clinical study done by [25]. Thus, the gingival status following sinus lift surgery was insignificant to the morbidity rate of either of the techniques.

In the retrospective study by [28] when talking about swelling it was mentioned that intraoral and extraoral swelling of Lateral sinus lift technique had a higher mean rank than the Percrestal sinus lift technique. Consistently, these facts are matched with the swelling outcomes in the randomized clinical trial article by [27] and the study by [25] where the Lateral sinus lift technique expressed higher swelling incidence rates in comparison with the Percrestal sinus lift technique. Since the lateral sinus lift technique is considered a more invasive surgery the swelling complication that occurs could be due to the vascular nature of the maxillary sinus cavity and this creates an obstacle in achieving hemostasis in the site [29]. In addition to that, in the study by [27] regarding bruising following the techniques, it was reported that the lateral sinus lift technique had a higher occurrence degree when compared to the Percrestal sinus Lift technique. This correlates with the information obtained from the study done by [28] in which the mean rank score of bruising in the lateral sinus lift technique was larger than in the Percrestal sinus lift technique. The development of bruising/hematoma is a postoperative complication that arises due to compromising the blood vessels of the maxillary sinus cavity [29]. Swelling and bruising are, in part, due to the more frequent use of releasing incisions and the longer duration of surgical procedure in the lateral sinus lift group when put in comparison with Percrestal sinus lift group [27]. In another study, statistically Higher VAS scores for swelling and bruising on surgery day are the outcome of a lengthier surgical procedure that took one hour or more as compared with the VAS score outcomes of patients whose surgical procedure was done within the scope of an hour. These findings corresponded with the one week follow up findings in which patients who were in a surgical procedure of a time frame of an hour or more experienced higher vas score for swelling, bruising and pain when put in comparison with patients in the hour-long surgical procedure. Furthermore, notably higher median VAS scores for swelling were the result of using periosteal releasing incisions in patients during surgery as when compared to surgeries without releasing incisions [30].

Nasal discharge/bleeding is another finding that is related to our research's morbidity rate criteria and was reported in the clinical trial by [27] in which the article stated that in the lateral sinus lift technique group, there was a higher rate of nasal discharge/bleeding than what was found in the Percrestal sinus lift technique group. Although insignificant, these clinical findings may be justified by the greater occurrence of membrane perforation accidents found in the Lateral sinus lift technique group when compared to the number of perforations found in the Percrestal sinus lift technique group [27]. In line with this justification, another article stated that postoperative nose bleeding might be the result of perforating the Schneiderian membrane. If these perforations were left without management, it creates a communicating channel between the sinus graft and the nasal cavity. Furthermore, increased vascularization of the area in the course of the healing phase and in the process of bone graft viability, blood might pool in the maxillary sinus cavity seeping into and out of the nose [29].

Schneiderian membrane perforation is among the most common complications of sinus augmentation procedures and is crucial in its effect on the integrity of the sinus and can compromise the survival of the bone graft placed [18]. Consistently, it is stated that the SM (Schneiderian membrane) perforation is a highly found intraoperative complication phenomenon during sinus lift surgeries with a frequency range of 7% to 44% [31, 32]. However, in four of the six articles that we chose to conduct our research study, perforations were found insignificant in the sense that, first, in the randomized clinical trial by [27] there was no difference seen in the occurrence of membrane perforation when comparing the lateral sinus lift technique with the Percrestal sinus lift technique. Second, in the retrospective study by [28] out of a total of ten cases, only one case experienced a SM perforation during the lateral sinus lift technique. Third, in the prospective study by [33] it was reported that a relatively small sized membrane perforation occurred at two sites during the sinus lift surgeries, one in each of the techniques, given that the sample size is thirty-six patients. Based on that, the clinicians did not exclude these two

cases from their study. Sinus membrane perforations are not an absolute contraindication for proceeding with the sinus floor surgery due to the fact that they could be sufficiently reconstructed and covered, given that they inhibit the passage of the graft material into the maxillary sinus [34,]. Fourth, in the clinical trial study by [35] one out of the ten patients experienced a membrane perforation incident during the Percrestal sinus lift technique procedure. Due to the limited visualization of the surgical site, the chance of SM perforation is ought to be higher in the Percrestal sinus lift technique than in the Lateral sinus lift technique [36].

Concerning the daily activity post operatively, it was found in the study done by [28] the mean rank in the lateral sinus lift technique expressed higher values when compared to the Percrestal sinus lift technique. Which conforms with findings in the research done by [27] in which it concludes that the daily activities such as: mouth opening, speaking, eating, swallowing, carrying out daily activities and doing activities related to school/ work in the lateral sinus lift technique had considerably higher limitation rates in contrast with the Percrestal sinus lift technique.

In the retrospective research article by [28] the Lateral sinus lift technique recorded notably lower mean rank score regarding vertigo than in the Percrestal sinus lift technique. In parallelism with this article, a study talks about the occurrence of vertigo following the extensive trauma that is accompanied by the use of the traditional osteotomes and mallet in the Percrestal sinus lift technique procedure [37].

In the retrospective study by [38] it was found that the outcome of either the lateral sinus lift technique and the Percrestal sinus lift technique, was not correlated to the period of edentulism in the posterior atrophic maxilla and was not impacted by it.

The most important criteria for choosing the suitable sinus lift technique are heavily dependable on the baseline height of residual bone. In which any sinus lift procedure requires a residual bone height equal to or less than 10 mm. A Residual bone height of more than 5mm is an indication for the Percrestal sinus lift technique whereas a residual bone height equal to 5mm or less which designates the use of the Lateral sinus lift technique [18]. It is stated that both the lateral sinus lift technique and the Per Crestal sinus lift technique have the ability to reach preferable outcomes in cases of an initial residual bone height equal or less than 6mm [33]. However, it was shown in other articles that the success rate of any of the mentioned techniques will decrease significantly in cases with an initial bone height with less than 4mm [39]. Maxillary sinus augmentation is not required in cases where the residual alveolar bone is above 12mm, but in cases where the residual alveolar bone is 6mm or more this calls for choosing a Percrestal sinus lift technique procedure. The lateral sinus lift technique procedure is preferred when the residual alveolar bone is 5mm or less [38]. In the clinical trial study by [25], The statistics of postoperative bone height gain showed significantly increased bone levels in the lateral sinus lift technique when compared to the Percrestal sinus lift technique. Although, the differences between the baseline bone height and the final bone height in both groups were notably divergent, it was stated in this article that at each of the follow up weeks, the bone height was not altered in any of the groups and that there was an increase in the radiopacity of the bone grafts placed over time. This correlates with results mentioned in the study done by [38] where it was observed that bone height gain was much greater in the lateral sinus technique when compared to the percrestal. Another article in line with these findings is a prospective study by [33] where in the lateral sinus lift technique group, notably greater ESBG (Endo-sinus bone gain) and ABH (Apical bone height) levels were found in comparison to the Percrestal sinus lift technique at a later follow up. The findings of another article are consistent with outcomes of our researcher's selected articles and the higher bone height gain increase in the lateral sinus lift technique when compared with the Percrestal sinus lift technique is explained by the smaller area of the maxillary sinus membrane influenced by the use of the crestally positioned osteotomes [40]. The placement of graft material in all cases of lateral sinus lift technique and the residual alveolar bone height itself are two factors that play a role in the difference of bone height gain between the lateral sinus lift technique and Percrestal sinus lift technique in which it was observed that the bone is gained much more [38].

There are other complications following both the Lateral sinus lift technique and the Percrestal sinus lift technique that were not mentioned in our selected articles but were mentioned in other studies. In the review by [26] it was mentioned that an intraoperative complication that is encountered in the lateral sinus lift surgery is tearing of



the buccal flap and injuring the infraorbital nerve in an inadequate surgery. These tears are usually the result of multiple attempts to achieve a releasing incision in the flap. Most postoperative complications seen in the Lateral sinus lift technique are uncommon and include sinus infections, postoperative sinusitis, graft infections, oroantral fistula, heavy postoperative bleeding, flap dehiscence, resultant graft volume that is inadequate for placement of implants, maxillary cyst formation and either rupture of the sinus membrane or exfoliation of graft material through the sinus window due to loss of graft material containment [41, 42]. Infections related to the Percrestal sinus lift technique might be in relation to contamination of the surface of the implant at the time of placement in the site, poor oral hygiene, contamination of graft material or the fact that the sinus has an underlying disease, especially in cases where sinus membrane perforations took place during the surgery [26]. Any surgical procedure is prone to infection of the site. No different is the sinus augmentation surgery. Although the probability of infection happening is low, it can still occur and have harmful effects on the graft placed and/or implants survival [29].

The Limitations that were faced in this study included: 1) the follow up methods in each of the six articles that were chosen to be included in this review had different techniques such as CBCT, CT scans, conventional radiographs and/or clinical follow ups, because of this, comparing the outcomes of the follow ups would be inadequate to conclude proper differences among the techniques. 2) The search for comparative articles that included both the lateral sinus lift and the Percrestal sinus lift techniques was another barrier that was faced in our research where not enough information in the literature involved the points that determined the clinical performance of each technique.

## CONCLUSION

Whether the clinicians decide to go for lateral sinus lift technique or percrestal sinus lift technique, it is important to keep in mind certain factors beforehand. Based on the selected articles in this systematic review and following our criteria, we concluded that the lateral sinus lift technique has a higher morbidity and success rate when compared to the percrestal sinus lift technique. However, that does not eliminate the fact that the percrestal sinus lift is a viable choice if a less invasive technique is necessary or if the alveolar bone height at baseline is not as diminished. Regardless of the technique chosen, the most crucial part in selection of either of the techniques depends on the residual bone level preoperatively followed by the obstacles faced by each of the surgeries.

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