

New Perspectives about Maxillary Sinus Lifting: a Literature Review

Novas Perspectivas sobre o Lifting do Seio Maxilar: Revisão da Literatura

Nuevas Perspectivas sobre el Elevación del Seno Maxilar: Revisión de la Literatura

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Abstract

Maxillary sinus lifting is a procedure for bone height gain in atrophic jaws. New safe and less complex manners have been evaluated, which use modifications of conventional techniques, through technologies such as devices and equipment that make them less traumatic. This study aims to conduct a literature review of articles found in the PubMed database between the years 2015 and 2020 that addresses advances in Maxillary sinus lifting techniques. We noticed that there is a development in the techniques that promotes the reduction of operative time, perforations and consequently a better postoperative for the patient, reducing the unpleasant perception of the surgery. The use of surgical ultrasound reduces the trauma to the soft tissues and the number of membrane perforations. A great step in the development of the sinus membrane lifting technique was the perception that bone formation is possible with the detachment of the membrane, not requiring the placement of a graft. There is no technique that replaces Maxillary Sinus Lifting yet. Only to improve it.

Descriptors: Maxillary Sinus; Sinus Floor Augmentation; Dental Implants; Piezosurgery; Osteotomy; Alveolar Bone Loss.

Resumo

O levantamento do seio maxilar é um procedimento para ganho de altura óssea em mandíbulas atroficas. Têm sido avaliadas novas formas seguras e menos complexas, que utilizam modificações das técnicas convencionais, através de tecnologias como dispositivos e equipamentos que as tornam menos traumáticas. Este estudo tem como objetivo realizar uma revisão de literatura de artigos encontrados na base de dados PubMed entre os anos de 2015 e 2020 que abordam os avanços nas técnicas de levantamento do seio maxilar. Percebemos que há um desenvolvimento nas técnicas que promove a redução do tempo operatório, perfurações e conseqüentemente um pós-operatório melhor para o paciente, diminuindo a percepção desagradável da cirurgia. O uso do ultrassom cirúrgico reduz o trauma nos tecidos moles e o número de perfurações da membrana. Um grande passo no desenvolvimento da técnica de levantamento da membrana sinusal foi a percepção de que a formação óssea é possível com o descolamento da membrana, não sendo necessária a colocação de enxerto. Ainda não existe uma técnica que substitua o Lifting de Seio Maxilar. Apenas para melhorá-lo.

Descritores: Seio Maxilar; Levantamento do Assoalho do Seio Maxilar; Implantes Dentários; Piezocirurgia; Osteotomia; Perda do Osso Alveolar.

Resumen

El levantamiento de seno maxilar es un procedimiento para ganar altura ósea en maxilares atroficos. Se han evaluado nuevas formas seguras y menos complejas, que utilizan modificaciones de las técnicas convencionales, a través de tecnologías como dispositivos y equipos que las hacen menos traumáticas. Este estudio tiene como objetivo realizar una revisión bibliográfica de artículos encontrados en la base de datos PubMed entre los años 2015 y 2020 que abordan los avances en las técnicas de elevación del seno maxilar. Notamos que hay un desarrollo en las técnicas que promueve la reducción del tiempo operatorio, de las perforaciones y conseqüentemente un mejor postoperatorio para el paciente, reduciendo la percepción desagradable de la cirugía. El uso de ultrasonido quirúrgico reduce el traumatismo de los tejidos blandos y el número de perforaciones de la membrana. Un gran paso en el desarrollo de la técnica de elevación de la membrana sinusal fue la percepción de que es posible la formación de hueso con el desprendimiento de la membrana, sin necesidad de colocar un injerto. Aún no existe una técnica que reemplace al Levantamiento de Seno Maxilar. Solo para mejorarlo.

Descriptorios: Seno Maxilar; Elevación del Piso del Seno Maxilar; Implantes Dentales; Piezocirurgia; Osteotomía; Pérdida de Hueso Alveolar.

INTRODUCTION

Maxillary sinus lifting (MSL) is a procedure for bone height gain in atrophic jaws. This method consists to raise the sinus membrane (Schneiderian membrane) to place a filling material in order to promote bone neof ormation. Thus, it allows the immediate or

subsequent installation of dental implants for patient rehabilitation¹⁻³.

There are several surgical techniques available for the elevation of sinus membrane, being considered traditional two techniques: the lateral approach (access through maxillary sinus lateral wall), more traumatic and consumes

more surgical time, and the technique that uses osteotomes with increasing diameters, Summers technique (atraumatic). However, such methods have limitations, since they are invasive and depend on the remaining bone height, which increases the risks of sinus membrane perforation and postoperative complications such as graft exposure, facial pain and swelling⁴⁻⁶.

Therefore, new safe and less complex approaches have been evaluated, which use modifications of such techniques, through technologies such as devices and equipment that make them less traumatic, with less risk of complications in the postoperative period⁷⁻¹⁰. These are minimally invasive strategies that use hydraulic pressure, preserve the alveolar bone crest and may dispense with filling materials in order to reduce patient discomfort, cost and time of surgery, and increase the success rate¹¹⁻¹⁴.

This study aims to conduct a literature review of articles found in the PubMed database between the years 2015 and 2020, which addresses advances in techniques for lifting the maxillary sinuses.

LITERATURE REVIEW

○ *Comparison between techniques*

The conventional techniques, Summers and lateral approach, must be applied in cases of jaws with severe atrophy and pneumatization of the jaws. The lateral approach consists in a modified Caldwell-Luc maneuver with buccal bone plate osteotomy with local anesthesia. The upper osteotomy depends on the planned increase in bone height, the lateral osteotomy being 4 millimeters distant from the adjacent teeth and lower than one 1 millimeter to the sinus floor¹⁵.

Summers' technique, also called alveolar or transalveolar method, depends on the minimum bone height remaining between 5 and 6 millimeters and allows bone gain of 4 to 8 millimeters in height. This approach consists of compacting bone in the apical and lateral directions, using osteotomes of increasing diameters with preservation of the bone crest, leaving 1 millimeter of bone between the site and the membrane¹⁵.

Among the modifications of these approaches, it is possible to identify the infiltrative techniques, which use liquid to elevate the membrane. This technique can be performed by means of a 5-millimeters diameter osteotomy in the alveolar region, which a balloon is inserted, then is filled with saline solution to elevate the sinus membrane. Thus, it

is a minimally invasive technique when compared to conventional methods and the bone gain is similar to the lateral approach that is the most traumatic¹⁶.

Crestal Approach System (CAS) is a system that uses hydraulic pressure to raise the sinus membrane and perform the osteotomy in a conical form, with a drill without active tip via alveolar. Consequently, it is considered predictable, safe and with lower morbidity compared to the conventional lateral approach. The survival rate of implants placed was 100 %, in a cohort study, with follow-up of the patients for two years, using CAS¹⁷.

The balloon method was considered the safest method when compared to the rotating system (CAS) and the conventional alveolar method. The former was considered the best method with 7 millimeters of bone gain in height and only one case of perforation, followed by CAS, with 5 millimeters of bone gain in height and one case of perforation. For the conventional alveolar method it was 5 perforations (58.4%)¹⁸.

The infiltrative technique and lateral approach, when associated to the simultaneous placement of implants, present substantial bone gain with low chance of membrane perforation or implant loss during the procedures in both techniques. So, the volume of bone formed in the infiltrative technique depends on the amount of liquid used to raise the sinus membrane¹⁹.

The membrane can be lifted directly through the implant channel by iRaise system, which lifts the membrane by hydraulic pressure and allows simultaneous grafting to the transalveolar technique, with immediate implant placement. The bone gain in height can be up to 12 millimeters and without failure in the installed implants (peri-implantitis, radiolucency and mobility), after 6 months of the procedure. However, there was a physiological contraction of bone volume of 13.9%²⁰.

We have evidence that the combination of techniques can lead to a higher success rate. The Summers technique together with a system using hydraulic pressure (infiltration technique), Sinus Physiolift, when compared to the piezosurgery technique, by the pressure system, obtained bone gain in similar height and volume, as well as membrane drilling rates²¹.

The infiltration technique, in the lateral approach, proved the reduction of the risks for Schneiderian membrane perforation, which can be explained due to the equal pressure distribution at all points during MSL. The

implants stability index was 72.09 ± 2.87^{22} .

The use of hydraulic pressure and vibration to raise the sinus membrane, the Jeder System, a technique considered minimally invasive, presented a low rate of perforation (8.9%) and the implants survival rate in 5 years was 89.7%. This technique presented good primary stability with bone remaining of 1 to 2 millimeters, without the need for a second approach²³. Residual bone height of 2 to 4 millimeters can be made using osteotomes with simultaneous placement of implants. This technique is usually performed on minimum bone height of 4 millimeters. There was a bone gain of approximately 10 millimeters in a 12-month follow-up. There was no perforation of the sinus membrane, whose thickness was 2 millimeters in evaluation by Cone-Beam Computed Tomography (CBCT). The implants survival rate was 100%²⁴.

○ *Type or absence of mucoperiosteal flap and extent of ostetotomy*

Regarding the type of flap used in surgery, pain and edema were evaluated in sinus lift surgeries by the lateral approach in relation to the technique with the use of osteotomes. Two types of mucoperiosteal flap were used: trapezoidal and triangular modified. With the evaluation of the visual, verbal and thermographic scale, it was observed that the temperature of the face, the edema and the pain were lower for the modified triangle²⁴.

Techniques without flap have been used when access is through alveolar bone crest. This technique has been considered safe, effective, minimally invasive and without post-operative discomfort. Another positive aspect is the better aesthetics for soft tissues than the conventional technique. However, it should be performed only by professionals with clinical experience, since changes in the surgical protocol are necessary and the fields of vision and for the surgery are more restricted²⁵.

Some authors have analyzed the difference in the size of the bone opening in lateral access, with access of 5 millimeters in diameter. It was noticed that there was no perforation of the membrane. This modified technique is interesting because the removal of less bone retains more osteogenic cells, which favors bone neoformation at the site. Another benefit is the lower risk of damage to the infraorbital nerve. However, the surgeon must have manual ability to work with restricted field of surgery and vision²⁶. In another study, two openings were compared, the first 10x8mm

(control) and the second 6x6mm. Patients of the test group reported through the analogical visual scale little discomfort and pain for the technique with the smallest window, which can be related to the lower inflammation²⁷.

○ *Technique without grafting*

MSL without the use of grafting is considered today as a viable technique. Studies indicate that lateral approach and immediate placement of implants is possible to obtain a success rate of 94%. The principle of this technique is that after the lifting of maxillary sinus membrane and installation of the implant, there will be a filling of the cavity with blood and followed by bone neoformation^{28,29}. Other study found the greater the protrusion of the implant, the smaller the bone gain, without loss of implant³⁰.

The placement of graft at the time of survey leads to faster bone formation, but both techniques (with or without graft) demonstrate equal in bone gain: height, density and stability³¹. The use of other biomaterials (*Aloe vera*) was analyzed and it was found that the placement of a material that supports the sinus membrane will promote greater bone formation than the blood clot^{32,33}. However, the use of platelet rich plasma did not make any difference for cases without grafting³⁴. Besides these studies, Gatti et al.¹⁷ and Park et al.¹⁹ found that it is possible to achieve high survival rates and success in the placement of implants by techniques without the use of graft.

○ *Immediate placement of implants*

The long-term effectiveness of maxillary sinus floor augmentation depends on whether implants are placed immediately or in a second stage. The success of the implant is not associated with the type of filling material (bone or bone substitute)³⁵. Stefanski et al.³⁶ have demonstrated that immediate placement is an adequate approach at a minimum bone height of 5 millimeters. However, bone height of 2 to 4 millimeters are sufficient to bring an initial stability to dental implant³⁷.

○ *Technological advances*

The surgical ultrasound (piezosurgery technique) has advantages, such as selective and precise cutting, superior to techniques with rotating instruments, being an innovative concept of minimally invasive osteotomy, with less bleeding and constant irrigation, which reduces necrosis and thermal damage, besides presenting minimum risk of accidents and damage to fragile structures, such as vessels and nerves³⁸ and minimizing the possibility of

sinus membrane perforation^{11,39-41}.

The use of endoscopy can facilitate the achievement of membrane detachment in a shorter operative time and consequently reduce postoperative complications and the number of membrane perforations⁴²⁻⁴⁴. This technique allows less exposure to radiation doses and greater precision of the technical approach, being less invasive than lateral approach of the maxillary sinus, with less surgical time and low morbidity⁴⁵.

The use of advanced guides made by 3D printers, obtained by CBCT, intraoral scanning and the model obtained by conventional molding⁴⁷, helps in the precision of the osteotomy in all cases, but there is limitation as the bone height, because it requires the skills of the surgeon not to extend the access above the guide⁴⁷.

Tubes containing a Nickel-Titanium wire are being tested with memory of form, with the purpose of detaching and raising the membrane. The authors were able to elevate the membrane in the mesial to distal direction by 19 ± 8.1 mm and buccal to palatal direction by 23 ± 4.9 millimeters. The elevator demonstrated to reduce the incidence of perforation, being considered a promising tool for MSL⁴⁸.

DISCUSSION

MSL is a proven technique for bone ridge augmentation in atrophic maxilla. It is performed by experienced surgeons, favoring the lowest probability of complications. We realize that there is a development in the techniques that promotes the reduction of operative time, perforations and consequently a better postoperative for the patient, reducing the unpleasant perception of the surgery^{8,12,15,28,29,43,47,48}.

Improvements in soft tissue manipulation have also brought better feelings of comfort to the patient since the manner of manipulation and duration of the surgery is the main responsible for postoperative discomfort and edema^{14,49}. The use of surgical ultrasound decreases soft tissue trauma and the number of membrane perforations^{2,11,21,30}.

A great step in the development of the sinus membrane lifting technique was the perception that bone formation is possible with the detachment of the membrane, not requiring the placement of graft^{15,44}. Everything assumes that the side of the membrane that makes contact with the bone, is nothing more than a periosteum rich in osteoprogenitor cells that facilitates neof ormation^{7,10}.

To facilitate bone formation, the ideal is to place some biomaterial interposing the membrane and the bone floor⁴. Thus, the possibility of immediate insertion of the implant is a perfect solution to the problem of a biocompatible material, being already the increase of bone height with the beginning of rehabilitation⁴⁹, taking care that the remaining bone has at least 2 millimeters for an initial stability of the implant²².

CONCLUSION

Technological advances in techniques and instruments are being developed with promising use for facilitating practice. MSL is a necessary technique to solve bone height problems in atrophic jaws and there is no technique to replace it yet. Only to improve it.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest.

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