MODIFICATIONS OF MAXILLARY SINUS ANATOMY AFTER SINUS AUGMENTATION – CONE BEAM CT ASSESSMENT

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MODIFICATIONS OF MAXILLARY SINUS ANATOMY AFTER SINUS AUGMENTATION – CONE BEAM CT ASSESSMENT (Abstract): Sinus augmentation is now part of the daily practive in oral surgery clinics. The majority of the studies from literature take into account the factors that can influence the surgery. The purpose of this study is to identify if sinus augmentation influences the anatomy of the maxillary sinus – ostium, sinusal mucosa and bone neoformation. Methods: 30 patients attending a private surgical practice (6 women and 24 men, with a mean age of 46,7 years, ranging between 29 and 54 years old) that underwent sinus augmentation in the past (postoperative period: 21 – 55 months) were evaluated. Cone Beam CT and 3D reconstructions of the sinuses were performed, using Planmeca Romexis Viewer 3.0.1, to assess the maxillary sinus: ostium patency, mucosal thickening, vestibular cortication and Hounsfield density for the bone graft. Results: Mucosal thickening was diagnosed in 60% of the cases, and the ostium was obstructed in 20% of the cases. The mean value of the HU density for the cortical bone was 419,75. Vestibular cortication was present in most of the cases (90%). Significant statistical correlations were found between: surgery complications and ostium obstruction ($p < 0.05$), preoperative sinusal pathology and ostium obstruction ($p < 0.05$), ostium obstruction and mucosal thickening ($p < 0.05$). Conclusions: Sinus augmentation does not bring a major influence on the anatomy of the maxillary sinus, but the changes can be a risk factor for the sinus disease. Therefore, they should be brought to knowledge to oral surgeons and ENT doctors, considering the fact that the maxillary sinus is a commun teritory. **Key words**: OSTIUM, SINUS MUCOSA, MAXILLARY SINUS, SINUS AUGMENTATION

INTRODUCTION

Implant-supported rehabilitation of the atrophic posterior maxilla often necessitates maxillary sinus surgery to augment existing bone volumes. Increased experience in sinus lifting procedures has led to a number of literature reports, but the potential effects of sinus lifting on sinus anatomy is not clearly addressed in clinical studies. The aim of this study was to objectively investigate the effects of sinus lifting on changes of sinus anatomy, in particular, ostium patency, mucosal thickening and bone neoformation.

Recent systematic reviews assessed the effect of anatomic factors, implant design and surface, individual risk factors, and complications related to sinus floor elevation procedures on implant survival through analyzing patient data.

A research team from Turkey performed acoustic analyses before and after surgery and recorded the volume changes in the sinuses before and after surgery. They found perturbation of the parameters of acoustic sound (1).

Altintas et al. (2) performed in 2013 a cone beam CT evaluation of augmented sinuses –

formation and density of new bone 1 week, 3 weeks and 6 month postoperatively. They assessed the Hounsfield unit (HU) values for the control zone and they evaluated the bone formation at the apices of the implants. The results suggest that new bone density after maxillary sinus membrane elevation without additional bone graft material was greater than that of bone formed after sinus augmentation with bone grafting.

Lee et al. (3) demonstrated a definite correlation between histologic and histomorphometric data with formation of new, vital autogenous trabecular bone and bone mineral density (quality). Bone mineral density was observed to steadily increase during the 52-week observation period, as evidenced by the increase in Hounsfield unit values. The Hounsfield unit values were recorded using cone beam computed tomography and 3D-CT interactive software.

There is a need for prospective, long-term follow-up studies of sinus anatomy after maxillary sinus floor augmentation.

MATERIAL AND METHODS

A total of 30 patients (24 male and 6 female) aged 29 - 54 years (mean age 46,7 years) were enrolled in this study. All of the patients had sinus augmentation in the past (21 months - 55 months).

These conditions were identified for the patients included in the study : patient age, gender, health status, smoking habits, periodontal disease, sinusal abnormalities before surgery, implant size, shape, and surface, timing of implant placement with respect to grafting, graft material, and the occurrence of surgical complications. An evaluation of subjective and objective symptomatology was also recorded before and after operation (purulent rhinorrhea, cacosmia, epistaxis, hypoesthesia).

A total of 32 sinus lifts were performed for the patients. In all, dental implants measuring 3.3-5 mm in width and 8-13 mm in length were placed in the same time with the sinus lifts (30%) or in a second stage (70%, after 9 months). Four implants each were inserted in grafted regions of 6 patients, whereas 3 implants each were inserted in the grafted regions of 18 other patients and other 3 patients received 2 implants for the grafted sinuses. Cone Beam CT assessments were conducted with Planmeca ProMax 3D, in a postoperative period of 21 months – 55 months.

The study was conducted with approval from the Ethics Committee of the "Gr.T. Popa" University of Medicine and Pharmacy, Iasi, Romania.

Inclusion criteria were : sinus augmentation in the past (minimum 1 year ago).

Exclusion criteria : mucosal perforation larger than 10 mm.

OBSERVERS

Two observers (oral and maxillofacial radiologists) were calibrated by reviewing and discussing 20 CBCT scans that had normal sinus findings or previously diagnosed sinusitis. For the study, the scans were reviewed by both the observers independently on a Dell 24-inch non-glossy monitor (1,920-1,200 resolution) with a Dell Precision Workstation using Planmeca Romexis Viewer 3.0.1. Each scan was reviewed in axial, coronal, and sagittal sections and in the "implant" view. If there was a disagreement on the diagnosis, a consensus was reached after a discussion between the two observers.

SURGICAL METHOD

All surgeries were performed by the same surgeon, with premedication (Ketonal 2 ml, Dexamethasone 2 ml) and under local anesthesia (articaine hydrochloride 4% with adrenaline 1 : 100.000, Ubistesin forte). The patients were asked to rinse preoperatively with chlorohexidine mouthwash 0.2% for 20 s. With a midcrestal incision and vertical releasing incision, a mucoperiosteal flap was elevated to expose the sinus wall. The preparation of the bone window was first accomplished with a round steel bur. The sinus membrane was then elevated, with the use of elevators (Kohler). The implant sockets were then prepared and the dental implants placed. The graft material (Bio-Oss 1-2mm, Geistlich) was placed in mixture with peripheral blood collected after Gentamicine, 80 mg, injection. The defect in the buccal wall was then covered with an absorbable membrane, Hypro-Sorb M membrane (bioImplon Gmbh, naturally pure crystalline absorbable sterile bovine atelocollagen). The soft tissue flaps were closed without tension to prevent any dehiscence with multiple horizontal mattress absorbable 3-0 sutures. Peripherative management included systemic antibiotics 1000 mg amoxicillinum 2 times a day for 7 days

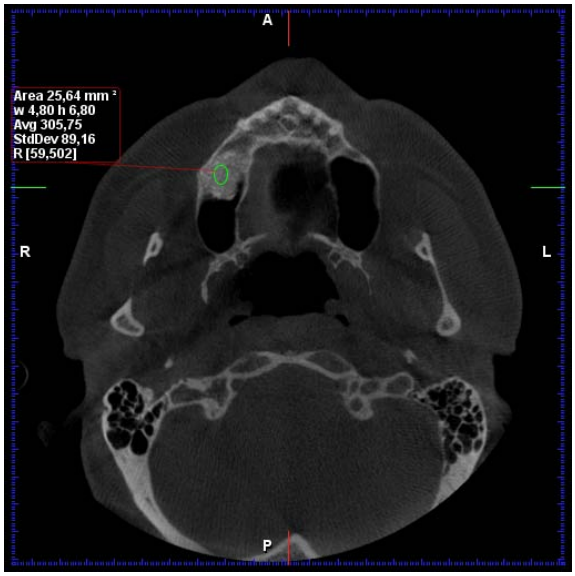

Fig. 1. A 41-month post-operative coronal view of the CBCT scan showing Hounsfield unit values

Fig. 2. A 28-month post-operative axial view of the CBCT scan showing scan showing the continuity and the cortical of the right buccal window

(Augmentin), application of decongestant nasal spray, chlorohexidine 0.2% (Corsodyl) mouthwash (twice a day for 10 days), and analgesics (Ketoprofen). The healing abutments were applied 8 months later.

In case of mucosa perforation (< 10mm), we used Hyprosorb F membrane to cover the defect and the intervention continued.

CONE – BEAM CT ASSESSMENT

All radiographic evaluations of patients were carried out with the use of Planmeca ProMax 3D cone-beam computerized tomography (CBCT) (500 slices, voxel size 400μm, 90 kv, 7 mA, 13,95s exposure time, 871,8 mG x ycm^2). For each sinus, using the software Planmeca Romexis Viewer 3.0.1, we assessed : mucosal thickening (> 1mm), ostium obstruction, vestibular cortication and Hounsfield density for the bone graft. A densitometric analysis was performed using the Hounsfield Unit (HU) scale in the software program. The thickness of the mucosa was determined at the maximum thickness from the sinus wall.

The posterior maxillary region (grafted area from the sinus) was selected for the control zone in every patient, and the HU values of the spongy bone were recorded. Because of space limitations of patients with multiple implants surgically placed, bone density (HU) of the graft material was measured above the apical portion of the implant for all patients. Measuring bone density above the apical portion of the implants also provided consistency in the area of measurement for all patients. In each control zone a 5.0 x 5.0 mm elliptical area was outlined to measure bone density in HU values.

STATISTICAL METHOD

The data analysis was performed with SPSS (Statistical Package for Social Science) version 20. For quantitative variables, the Pearson correlation was used. The chi-square test and Fisher's Exact Test (for samples smaller than five units) were used for qualitative variables. An error probability of < .05 was accepted as significant.

RESULTS

The average follow-up time was 33,8 months and the longest follow-up period was 55 months.

New bone formation was determined in both groups using Hounsfield density values. The lowest value was seen in the graft that didn't received the implants, 251,73 HU (fig. 1).

The highest value was 872 HU and the mean value for the bony graft was 552,50. The mean value of the HU density for the cortical bone was 419,75, and for the imediat post-op follow up was 187,7.

The grafted area appeared to be markedly denser than the autogenous bone (fig. 2).

The lateral wall of the former defect buccal window area seemed to be healed fully and the continuity of the bone was achieved. Vestibular

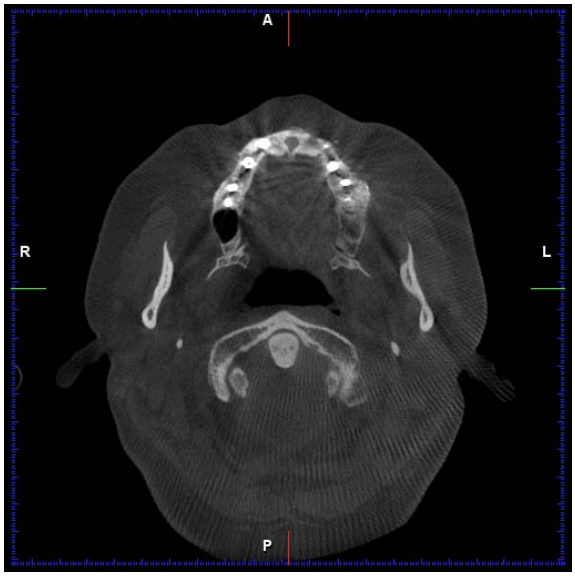

Fig. 3. A 55-month post-operative axial view of the CBCT scan showing some irregularities on the buccal wall of the left maxillary sinus

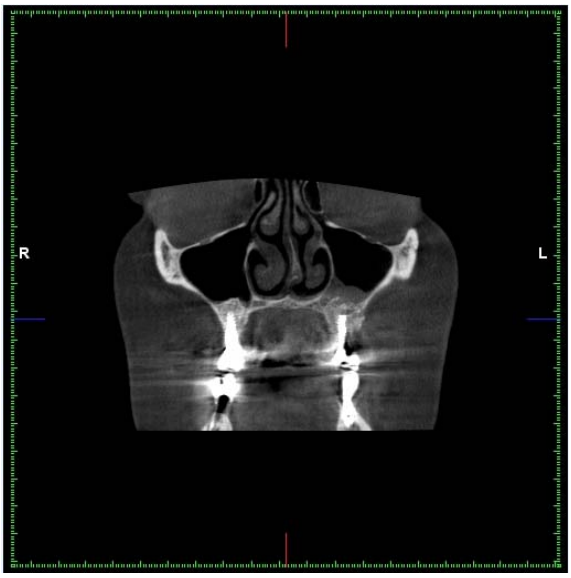

Fig. 4. A 55-month post-operative coronal view of the CBCT scan showing some irregularities on the buccal wall of the left maxillary sinus and mucosal thickening

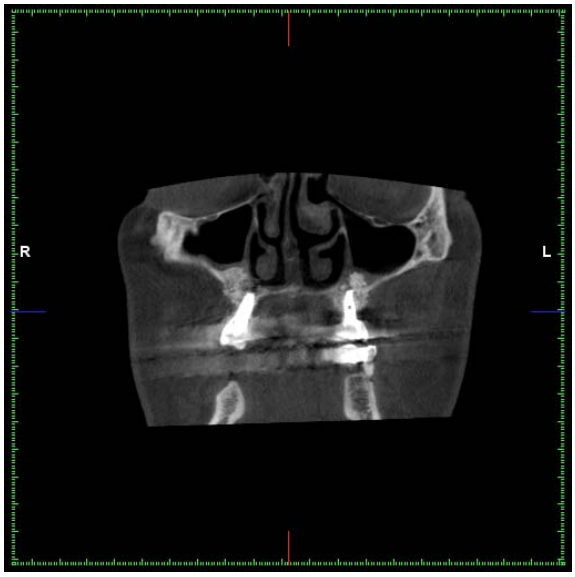

Fig. 5. A 55-month post-operative coronal view of the CBCT scan showing right ostium obstruction

cortication was present in most of the cases (90%) (fig. 3, 4).

The change of buccal defect in the lateral wall was evaluated radiographically using the axial and coronal view and the cortication of the buccal window was seen.

Ostium obstruction was seen in 20% cases and mucosal thickening was observed in 60% (fig. 5).

Intraoperative sinus membrane perforation occurred in 10% sinuses, and the patients declared the presence of epistaxis after the surgery.

At the immediat post-op control, one patient had purulent rhinorrhea. Antibiotics were recommended for 14 days, and the purulent nasal discharge stopped.

There was no implant failure according to Albrektsson criteria (4).

All patients were asymptomatic at the moment of evaluation (hypoesthesia, cacosmia, epistaxis, purulent rhinorrhea).

2 patients declared smoking more than 15 cigarettes/day. Periodontal disease was present in all cases and 3 patients had sinusal pseudocyst. 1 patient had multinodular goiter and was under treatment with thiamazolum (Thyrozol) and 4 patients were hypertensives under treatment with Indapidum (Tertensif), Nicergolinum (Sermion), Trimetazidinum (Preductal) and Nebivololum (Nebilet). 1 patient had puss in the sinus and a pseudocyst.

Fisher's Exact Test showed statistical correlation between : complications (mucosa perforation) and ostium obstruction ($p < 0.05$), preoperative sinusal pathology and ostium obstruction ($p < 0.06$)

The Pearson correlation showed a positive association between ostium obstruction and mucosal thickening (significance level was .001 (2-tailed).

DISCUSSION

The sinus lift procedure has become an important element in the treatment of the edentu-

lous posterior maxilla (Jensen et al.,1998). The changes that could come up after surgery should be brought to knowledge, to oral surgeons, but also to ENT doctors, because the maxillary sinus is a commun territory.

There are many studies that evaluate various factors related to the surgery that could influence the outcome, but there is not one to evaluate the influence of the surgery on the maxillary sinus.

A research team from Turkey evaluated the changes in the values of Jita and Jitt perturbation parameters, that resulted in positive changes in sound quality. Because sinus lifts reduce the size of the paranasal sinus system, alterations in voice quality can not be ruled out. The potential effects of sinus lifting on voice quality have yet to be clearly addressed (1).

The reduced sinus volume could influence the average air flow rates. We did not observe any change of the maxillary sinus anatomy, but further investigations should be made on longer periods of time.

The cases studied by Guimaraes suggest that the posterior nasal airflow did not have any crucial role in the sinus development of the patients. In the literature we find little evidence built by well structured methodology studies that corroborate the lack of nasal airflow causing sinusal disease (5).

Cone-beam computed tomography (CBCT) provides detailed three-dimensional images of the structures scanned. Computed tomography scanning has become the standard in medicine for visualizing the maxillary sinuses because of the ability to visualize both bone and soft tissue in multiple views with thin sectioning (6).

It has been demonstrated that the grey levels taken from Planmeca ProMax 3D CBCT scans can be used to derive Hounsfield units in a clinical environment (7).

The study performed by Soardy *et al*. (8) compared cone beam computed tomography and microradiography in the evaluation of bone density after maxillary sinus augmentation and demonstrated the predictability of the CBCT analysis.

The resolution of the defect in the lateral wall may serve as an index for the healing state and remodeling of the graft material (9).

We observed that the lowest values of the bone density were seen in the graft that did not receive the implants, so we conclude that the implant is a key factor for the succes of the bony graft. We did not take in consideration bone resorbtion of the graft but the apices of the implants were covered with bone. We also observed that the mean value of the Hounsfield unit values for the graft were higher than the mean values for the cortical bone.

Implant survival is dependent on both bone quantity and quality (1,7). Bone quantity (volume) is the amount of available bone for implant placement in the jaws. Bone quality refers to the amount of mineralization, or density of bone in the area of implant placement. Both factors have been determined to be important predictors of implant success (3).

In the present study, the changes we found in the sinus anatomy could be risk factors for sinus disease. There are various studies that discuss the effects of different factors on the development of sinus disease - a prospective study involving 500 patients on the effect of septal deviation in the genesis of chronic rhinosinusitis also suggested that air flow alterations caused by nasal septum deviations do not bear an effective role in chronic rhinosinusitis development (5).

One of the limitations of our study is that the evaluation period is large, 21-55 months, and differs from one patient to another. Further studies that evaluate the long-term outcome of the surgery and after the same postoperative period should be performed.

CONCLUSIONS

The following conclusions can be made :

1. Oral surgeons and ENT doctors should be aware of the possible variations of maxillary sinus anatomy or the surgeries that could influence it ;
2. The anatomical changes found can be risc factors for sinus disease ;
3. There are no side effects of sinus augmentation, in a long-term evaluation.

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