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Subantral Bone Loss Specification

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Abstract: ***This study aimed to develop a specification of the subantral bone loss. Materials and methods: We performed a monocentric, retrospective study of 76 preoperative cone-beam computed tomography (CBCT) images of patients who underwent maxillary sinus floor augmentation (MSFA) procedure with lateral approach between 2014 and 2021. A total of 108 sinuses with 305 missing teeth regions were observed. Results: Subantral bone height (SBH) decreased from premolar (10, 80 mm ± 3, 31 mm) to molar region, subantral bone width (SBW) and maxillary sinus width (MSW) increased from premolar (6, 27 mm ± 2, 07 mm and 5, 98 mm ± 2, 31 mm) to molar region (8, 50 mm ± 2, 78mm and 11, 40 mm ± 2, 95mm). Differences estimatedby Kruskal-Wallis analysis p<0.0001 are statistically reliable. It was established significant inverse relation between MSW u SBH p< 0, 01. There was a significant direct relation between MSW and SBW p<0, 01. Conclusion: Our study describes the trends in the sizes of SBH, SBW and MSW. We believe that our results could be helpful for future clinical researches to establish a relationship between SBW and MSFA procedure success, as there are already studies looking for a relation between MSWand MSFA success.***

Keywords: subantral bone loss, sinus floor augmentation, maxillary sinus width, subantral bone width, subantral bone height

1. Introduction

MSFAis a procedure for permanent creation of the necessary volume of the subantral bone (SB) for dental implants placement in the distal edentulous regions in themaxilla. Misch and Judy describe their classification of available bone in terms of implant treatment options. The "available bone" is the volume of bone in the edentulous region, intended for implantation (11). Dietrich et al. found that the implant should be surrounded by 1-1, 5 mm bone, both vestibular and oral, and distal and medial to adjacent teeth. This means that the minimum width of the bone when placing implants with a standard diameter is at least 6-7 mm (5, 13). Cawood and Howell analyze the earlier horizontal and subsequent vertical resorbtion of the bone, which affects the alveolar bone in maxilla and mandible, while the base of the jaws remains relatively unaffected by the process (9, 20). Douglass et al. pay attention to the centripetal resorbtion of the maxilla and the centrifugal resorbtion of the mandible (9). MSFA is a procedure for augmentation of SB in maxillary sinus cavity direction. (15). There are two main types of methods required for MSFA-closed methods (osteotomy technique) and open methods (technique with lateral approach) (16). A thorough diagnosis must be made before MSFA. For the purposes of this diagnosis, a three-dimensional image obtained using a CBCT is used. In alveolar bone augmentation, the 3D image obtained by CBCT allows the examination of the recipient bed and accurate assessment the amount of bone regeneration needed (1, 8).

2. Materials and Methods

We performed a monocentric, retrospective study of preoperative CBCT images, taken at the X-ray Diagnostic Department of the University Medical and Dental Center of Medical University –Varna, Bulgaria on patients, who underwent MSFE with lateral approach, unilateral or bilateral, with the simultaneous or delayed dental implants placement for rehabilitation of the masticatory apparatus in the period 2014 to 2021. The study included 76 3D images of the entire maxilla and MS in which no alteration in the sinus mucoperiosteum was observed, i. e., Schneiderian membrane thickness < 2mm. Selected images ranged from single edentulous sections in the region of the first maxillary molar, partially distally restricted and unrestricted edentulous sections to totally edentulous maxilla. Since the study conducted was retrospective, indications for CBCT imaging could not be defined. Patients included in the study signed an informed consent stating that the imaging data obtained may be used for research.

A total of 76 preoperative CBCTs of patients who underwent MSFA augmentation procedure with the lateral approach were reviewed.50 of these patients were males (66%), and 26 were females (34%).

The mean age of the male patients was 52, 82 +/-9, 4 years (28-71). The mean age of the female patients was 47, 19 +/-10, 6 years (25-68). Patients were divided according to the World Health Organization (WHO) age group classification (Aging classify cation according to WHO) (7). Patients whose preoperative CBCTs were included in the study were arranged in the following age groups according to the WHO age group classification: 15-44 years (young age) were 21 patients (27%), 45-59 years (middle age) were 40 patients (53%) and 60-74 years (elderly) were 15 patients (20%). In the young age group, there were 21 patients in total; 9 of them were male and represented 18% of the total number of males, and 12 were female and represented 46.2% of the total number of females. There were 40 patients in the middle-aged group, 29 of whom were male and accounted for 58% of the total number of males, and 11 of whom were female and accounted for 42.3% of the total number of females. In the elderly group, there were 15 patients; 12 of them were male, accounting for 24% of the total number of males, while females were three and accounted for 11.5% of the total number. Groups 0-14 years (childhood), 75-89

years (old age) and 90+ years (longevity), did not include any patients in the study. Of the 76 preoperative CBCTs of patients who underwent MSFA with lateral approach, 108 maxillary sinuses were observed, and a total of 305 missing teeth were found.

These 305 missing teeth were divided according to the size of the defect and the number of missing teeth in it according to the FDI into six groups. In all 108 sinuses observed, the first molar was missing (whether 16 or 26 is meant denoted as region M_1). The first group includes 8 of the observed sinuses. The absence of the first molar is independent, representing 7% of the observed sinuses and 3% of all missing teeth.

The second group represents a defect of two missing teeth, the second premolar and the first molar (whether we consider 15 and 16 or 25 and 26, we designate them as region PM_2 and M_1). This defect was observed in 7 of all 108 sinuses, representing 7% of these and 4% of all missing teeth. Third group, missing first and second molars (whether 16 and 17 or 26 and 27 we denote as region M_1 and M_2), with the number of this type of defect observed in 31 of all 108 sinuses observed. This represents 29% of the observed sinuses and 20% of the total number of missing teeth. A fourth group, missing first and second premolars and first molars (whether 14, 15, and 16 or 24, 25, and 26, we designate as region PM_1, PM_2 and M_1), with the number of this type of defect observed in 4 of all 108 sinuses observed. This represents 4% of the observed sinuses and 4% of the total number of missing teeth. The fifth group, missing second premolars, first and second molars (whether 15, 16, and 17 or 25, 26, and 27, we designate as region PM_2, M_1 and M_2), with the number of this type of defect observed in 23 of all 108 sinuses observed. This represents 21% of the observed sinuses and 23% of the total number of missing teeth. The sixth group, missing first and second premolars, first and second molars (whether 14, 15, 16, and 17 or 24, 25, 26, and 27, we designate as region PM_1, PM_2, M_1 and M_2), with the number of this type of defect observed in 35 of all 108 sinuses observed. This represents 32% of the observed sinuses and 46% of the total number of missing teeth. In all 76 preoperative CBCT studies of patients and all 108 observed sinuses, each of the 305 missing teeth observed on the paraxial section of the CBCT was measured the following three criteria, measured in milimeters:

- SBH in the region of the missing tooth, starting from the ridge of the alveolar ridge to the floor of the maxillary sinus (Figure1).
- SBW in the missing tooth region, taking as a starting point the distance between the vestibular and palatal compacts of the alveolar ridge in the vestibule-palatal direction (Figure 1).
- MSW starting from the medial and lateral walls of the maxillary sinus in the vestibular-palatal direction at a distance of 8 mm from the ridge of the alveolar ridge, and this parameter is measured only in regions of missing teeth, where SBH <8mm (Figure1).

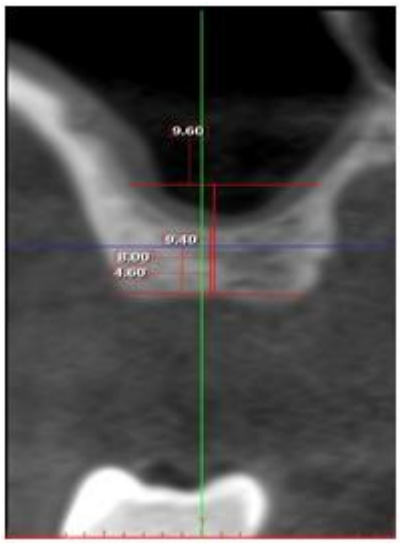

Figure 1

Data for SBH, SBW, and MSW were analyzed according to the gender, age of the patient, the size of the edentulous defect, and the number of missing teeth in it using IBM SPSS Statistics 25. The following statistical methods were used to prepare the statistical analysis of the collected data: parametric tests-Student criteria (t-test) for independent samples and ANOVA-test for comparison of more than two groups and non-parametric tests-Mann-Whitney test (U-criterion) for independent samples and Kruskal-Wallis test for comparison of more than two groups.

3. Results

The obtained data for the three criteria SBH, SBW, and MSW for regions PM_1, PM_2, M_1 и M_2 set out in table 1, were subjected to a check for normality of the distribution of data according to Kolmogorov-Smirnov, which showed that the distribution of the data for the three criteria is normal for regions PM_1 and district M_2. However, for regions PM_2 u M_1, data distribution is not normal.

3.1 Genderanalysis

Region PM_1. The quantitative and percentage distribution by gender of the studied 39 regions with established lack of teeth in the region of PM_1 is 24 male patients (62%) and 15 female patients (38%). SBH in the PM_1 region in men is expected to be 9, 99 mm ÷ 12, 85 mm with a 95% confidence interval, and in women, 8, 14 mm ÷ 11, 48 mm with a 95% confidence interval. SBW in the field of PM_1 for men is expected to be 5, 95 mm ÷ 7, 71 mm with a 95% confidence interval, and for women, 4, 39 mm ÷ 6, 37 mm with a 95% confidence interval. From the data obtained for MSW in the PM_1region for 5 of the 24 missing tooth region of PM_1 for male patients for whom SBH measured <8 mm, we found that the mean value of the measured MSW was 6, 68 mm ± 2.19 mm with a range of 5, 40 mm, with a minimum measured value (min) of 4, 00 mm and a maximum measured value (max) of 9, 40 mm. MSW by men is expected to be 3, 96mm ÷ 9, 40mm with a 95% confidence interval. Of the data obtained for MSW with a missing tooth in the PM_1region and for female patients for whom SBH measured <8 mm, 3 out of 15 regions. MSW 3,

40 mm, 4, 24 mm, and 6, 80mm were measured. The data analysis showed a statistically significant difference in the amount of SBW in the PM_1 region relative to the patient's gender p<0, 05. There was no statistically significant difference in the size of SBH in the region of PM_1 relative to the gender of the patient p>0.05. Due to the small number of cases studied, no analysis of the size of MSW by gender was performed.

Region PM_2. The quantitative and percentage distribution by gender of the studied 69 regions with established lack of teeth in the region PM_2 is 46 male patients (67%) and 23 female patients (33%). Data analysis showed a statistically significant difference in the size of SBH and SBW in the PM_2 region relative to the patient's gender p≤0, 05. However, there was no statistically significant difference for MSW in PM_2region relative to the patient's genderp≥0.05.

Region M_1. The quantitative and percentage distribution by gender, of the studied 108 regions with established lack of teeth in the region of M_1 is 71 male patients (66%) and 37 female patients (34%). The data analysis did not show a statistically significant difference in the size of SBH and SBW and MSW in the M_1 region according to the patient's genderp≥0.05.

Region M_2. The quantitative and percentage distribution by gender, of the studied 89 regions with established lack of teeth in the M_2 region is 63 male patients (71%) and 26 female patients (29%). SBH in the M_2 region for men is expected to be 3, 27 mm ÷ 4, 13 mm with 95% confidence interval, and for women 2, 71 mm ÷ 4, 15 mm with a 95% confidence interval. SBW in the M_2 region for men is expected to be 8, 35 mm ÷ 9, 68mm with a 95% confidence interval, and for women 6, 13 mm ÷ 8, 35 mm with a 95% confidence interval. MSW in the M_2 region in men is expected to be 10, 51 mm ÷ 12, 02 mm with a 95% confidence interval, and in women 10, 58 mm ÷ 12, 89 mm with a 95% confidence interval. The data analysis revealed a statistically significant difference for SBW in M_2 compared to the gender of the patient p≤0.05. However, there was no statistically significant difference in the size of SBH and MSW in the M_2 region relative to the patient's gender p≥0.05. The analyzed gender data for the three criteria, SBH, SBW, and MSW are shown in Table 2.

3.2 Age analysis

Region PM_1. The quantitative and percentage distribution of the studied 39 regions by age group with established lack of tooth in the region PM_1 according to the classification for the age groups of the WHO is: 9 regions (23%) are for young patients (15-44 years), 18 regions (46%) are for middle-aged patients (45-59 years), 12 regions (31%) are for patients in the adult group people (60-74 years). From the obtained MSW data for 8 of a total of 39 missing tooth regions in the PM_1 region, for which SBH is measured at <8 mm, we measured in 2 young patients acc. WHO (15-44 years) MSW 6, 80 mm and 8, 00 mm, respectively, in 6 middle-aged patients acc. WHO (45-59 years) we found that the average value of the measured MSW is 5, 51 mm ± 2, 28 mm with a range of 6, 00 mm., as the min is 3, 40 mm andmax is 9, 40 mm. The elderly group acc. WHO (60-74 years) with missing teeth in region PM_1, for which SBH < 8 mm was measured, does not include patients. MSW by middle-aged patients (45-59 years) 3, 11 mm ÷ 7, 90 mm again with 95% confidence interval. The analysis of the data showed a statistically significant difference in SBW in the region of PM_1 compared to the patient's age p≤0.05. There was no statistically significant difference in SBH compared to the patient's age p≥0.05. Due to the small number of cases studied, no age-related analysis for MSW was performed.

RegionPM_2. The quantitative and percentage distribution of the studied 69 regions by age group with established lack of teeth in the PM_2 region acc. WHO is: 17 regions (24.5%) are young patients (15-44 years), 35 regions (51%) are middle-aged patients (45-59 years), 17 regions (24.5%) are elderly patients (60-74 years). The data analysis showed a statistically significant difference in SBH in the PM_2 region compared to the patient's age p≤0.05. On the other hand, there was no statistically significant difference in SBW and MSW in the PM_2 region concerning the patient's age p≥0.05.

Region M_1. The quantitative and percentage distribution of the studied 108 areas by age group with established lack of teeth in region M_1 acc. WHO is: 31 regions (29%) are young patients (15-44 years), 57 regions (53%) are middle-aged patients (45-59 years), 20 regions (18%) are elderly patients (60-74 years). The data analysis did not show a statistically significant difference in SBH and SBW and MSW in the M_1 region compared to the patient's age p≥0.05.

Region M_2. The quantitative and percentage distribution of the studied 89 regions by age group with established lack of teeth in region M_2 acc. WHO is: 22 regions (25%) are young patients (15-44 years), 49 regions (55%) are middle-aged patients (45-59 years), 18 regions (20%) are elderly patients (60-74 years). SBH in region M_2 in young patients (15-44 years) is expected to be 2, 61 mm ÷ 4, 07 mm with a 95% confidence interval in middle-aged patients (45-59 years), 3, 11 mm ÷ 4, 15 mm with 95% confidence interval, and in patients from the elderly group (60-74 years), 3, 17 mm ÷ 4, 70 mm again with 95% confidence interval. SBW in region M_2 in young patients (15-44 years) is expected to be 6, 86 mm ÷ 9, 18 mm with a 95% confidence interval; in middle-aged patients (45-59 years), 7, 72 mm ÷ 9, 21 mm with 95% confidence interval, and in patients from the elderly group (60-74 years) 7, 46 mm ÷ 10, 85 mm again with 95% confidence interval. MSW in region M_2 in young patients (15-44 years) is expected to be 10, 54 mm ÷ 13, 13 mm with a 95% confidence interval; in middle-aged patients (45-59 years), 10, 28 mm ÷ 12, 06 mm again with 95% confidence interval, and in patients in the elderly group (60-74 years) 10, 14 mm ÷ 12, 84 mm again with 95% confidence interval. The data analysis did not show a statistically significant difference in the size of SBH and SBW and MSW in the M_2 region compared to the patient's age p≥0.05. The analyzed age data for the three criteria, SBH, SBW, and MSW, are shown in Table 3.

3.3 Analysis of the size of the defect and the position of the missing teeth

Region PM_1. The quantitative and percentage distribution of the studied 39 regions with established lack of tooth in the

region of PM_1 according to the size of the edentulous defect and the position ofmissing teeth in it are four patients with the size of the edentulous defect and the position of the missing teeth in its regions PM_1-M_1, which represents 10%, and 35 patients with the size of the edentulous defect and the position of the missing teeth in it areas PM_1-M_2, which represents 90%. Data for SBH from a total of 4 areas with missing teeth in the region PM ❑ with the size of the edentulous defect and the position of the missing teeth in it PM_1-M_1were measured at the following values for SBH respectively in two patients 8, 16 mm, 6, 23 mm and 11, 24mm. SBH for patients with the size of the edentulous defect and the position of the missing teeth in it PM_1-M_2 9, 93 mm ÷ 12, 22 mm again with 95% confidence interval. Data for SBW from 4 regions with missing teeth in region 4 with the size of the edentulous defect and the position of the missing teeth in it PM_1-M_1, the following values for SBW were measured in two patients 8, 00 mm, 7, 10 mm and 6, 30mm. SBW for patients with the size of the edentulous defect and the position of the missing teeth in it PM_1-M_2 5, 41 mm ÷ 6, 89 mm again with a 95% confidence interval. From the obtained data for MSW for 1 of a total of 4 areas with a missing tooth in the region PM_1 with the size of the edentulous defect and the position of the missing teeth in it PM_1-M_1, for which SBH was measured <8mm, we found a value of MSW 6, 80mm. MSW in patients with the size of the edentulous defect and the position of the missing teeth in it PM_1-M_2 is expected to be 3, 75 mm ÷ 7, 97 mm with a 95% confidence interval. It is impossible to analyze the data due to the small number of cases falling into the studied region PM_1-M_1.

Region PM_2. The quantitative and percentage distribution of the studied 69 regions with established tooth absence in the PM_2 region concerning the size of the edentulous defect and the position of the missing teeth in it is seven patients with edentulous defect size and the position of the missing teeth in the region PM_2-M_1, which represents 10%, four patients with the size of the edentulous defect and the position of the missing teeth in it regions PM_1-M_1, which represents 6%, 23 patients with the size of the edentulous defect and the position of the missing teeth in it regions PM_2-M_2, which represents 33% and 35 patients with the size of the edentulous defect and the position of the missing teeth in it regions PM_1-M_2, which represents 51%. From the obtained data for SBH from a total of 4 areas with a missing tooth in PM_2 region with the size of the edentulous defect and the position of the missing teeth in it PM_1-M_1, the following values for SBH were measured respectively at 6, 12 mm, 8, 00 mm, 3, 00 mm and 6, 12mm. The data analysis does not show a statistically significant difference in the size of SBH and SBW and MSW in the PM_2 region compared to the size of the edentulous defect and the position of the missing teeth in it $p \geq 0.05$. The data analysis does not include the data for the region PM_2 in an edentulous defect in the region PM_1-M_1 due to the low number of cases.

Region M_1. The quantitative and percentage distribution of the studied 108 regions with established tooth absence in the M_1 region concerning the size of the edentulous defect and the position of the missing teeth in it is: 8 patients with the size of the edentulous defect and the position of the missing teeth in the M_1 region alone, which represents 7%, 7 patients with the size of the edentulous defect and the position of the missing teeth in it regions PM_2-M_1, which represents 7%, 31 patients with the size of the edentulous defect and the position of the missing teeth in it regions M_1-M_2, which represents 29%, 4 patients with the size of the edentulous defect and the position of the missing teeth in its regions PM_1-M_1, which represents 4%, 23 patients with the size of the edentulous defect and the position of the missing teeth in regions PM_2-M_2, which represents 21% and 35 patients with the size of the edentulous defect and the position of the missing teeth in it regions PM_1-M_2, which represents 32%. From the obtained data for SBH from a total of 4 regions with a missing tooth in the region M_1 with the size of the edentulous defect and the position of the missing teeth in PM_1-M_1, the following values for SBH were measured respectively 6, 12 mm, 8, 00 mm, 3, 00 mm and 6, 12mm. From the obtained data for SBW from a total of 4 regions with a missing tooth in region M_1 with the size of the edentulous defect and the position of the missing teeth in PM_1-M_1, the following values for SBW were measured respectively 8, 00 mm, 5, 80 mm, 8, 00 mm and 6, 40mm. From the obtained data for MSW from a total of 4 areas with a missing tooth in region M_1 with the size of the edentulous defect and the position of the missing teeth in it PM_1-M_1, the following values for MSW were measured, respectively 11, 80 mm, 7, 20 mm., 5, 20 mm. and 7, 20mm. Due to the low number of cases, the data analysis does not include data from region M_1 in an edentulous defect in region PM_1-M_1. The analysis of the data shows a statistically significant difference in the size of the SBH in region M_1 compared to the size of the edentulous defect and the position of the missing teeth in it $p \leq 0.05$. However, there was no statistically significant difference in the size of SBW and MSW in area M_1 compared to the size of the edentulous defect and the position of the missing teeth in itp ≥ 0.05.

Region M_2. The quantitative and percentage distribution of the studied 108 regions with established tooth absence in the M_2 region about the size of the edentulous defect and the position of the missing teeth in it is: 31 patients with the size of the edentulous defect and the position of the missing teeth in M_1-M_2, which represents 35%, 23 patients with the size of the edentulous defect and the position of the missing teeth in its regions PM_2-M_2, which represents 26%, and 35 patients with the size of the edentulous defect and the position of the missing teeth in it regions PM_1-M_2, which represents 39%. SBH for patients with the size of the edentulous defect and the position of the missing teeth in it M_1-M_2 is expected to be 3, 07 mm ÷ 4, 15 mm with a 95% confidence interval; in patients with the size of the edentulous defect and the position of the missing teeth in PM_2-M_2 3, 31 mm ÷ 4, 89 mm again with 95% confidence interval, and in patients with the size of the edentulous defect and the position of the missing teeth in it PM_1-M_2-2, 70 mm ÷ 3, 95 mm again with a 95% confidence interval. SBW for patients with the size of the edentulous defect and the position of the missing teeth in it M_1-M_2 is expected to be 7, 67 mm ÷ 9, 55 mm with a 95% confidence interval; in patients with the size of the edentulous defect and the position of the missing teeth in PM_2-M_2-7, 71 mm ÷ 9, 99 mm again with 95% confidence interval, and in patients with the size of the edentulous defect and the position of the missing teeth in it PM_1-M_2-7, 12 mm ÷ 9, 23 mm again with a 95% confidence interval.

MSW in patients with the size of the edentulous defect and the position of the missing teeth in it M_1-M_2 is expected to be 10, 05 mm ÷ 12, 28 mm with a 95% confidence interval; in patients with the size of the edentulous defect and the position of the missing teeth in PM_2-M_2-9, 74 mm ÷ 12, 16mm again with 95% confidence interval, and in patients with the size of the edentulous defect and the position of the missing teeth in it PM_1-M_2-10, 88 mm ÷ 12, 94mm again with 95% confidence interval. The data analysis does not show a statistically significant difference in SBH and SBW and MSW in region M_2 compared to the size of the edentulous defect and the position of the missing teeth in it $p \geq 0.05$. The analyzed data against the size of the edentulous defect and the position of the missing teeth in it for the three criteria SBH, SBW, and MSW are shown in Table 4.

In conclusion, the data analysis for the regions PM_1, PM_2, M_1 и M_2 showed that SBH decreased from the premolar to the molar area (Figure 2), and SBW and MSW increased from the premolar to the molar area (Figures 3, 4), which was confirmed by Kruskal-Wallis $p<0.0001$.

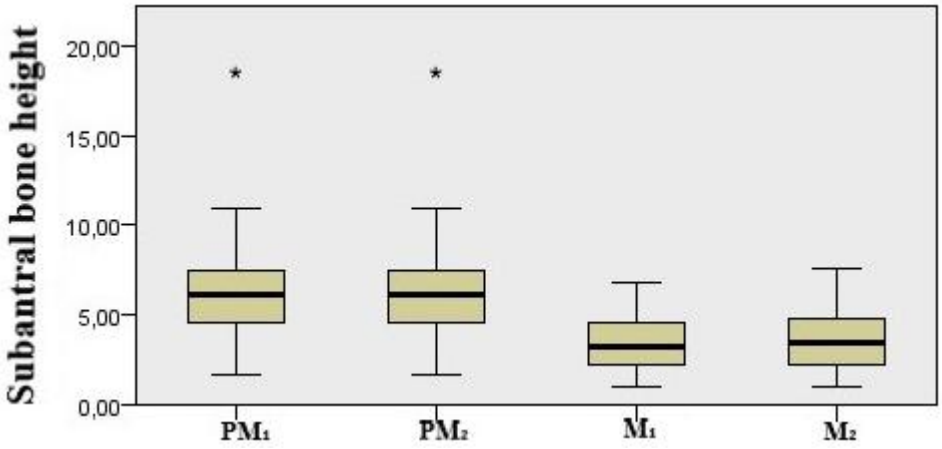

Figure 2

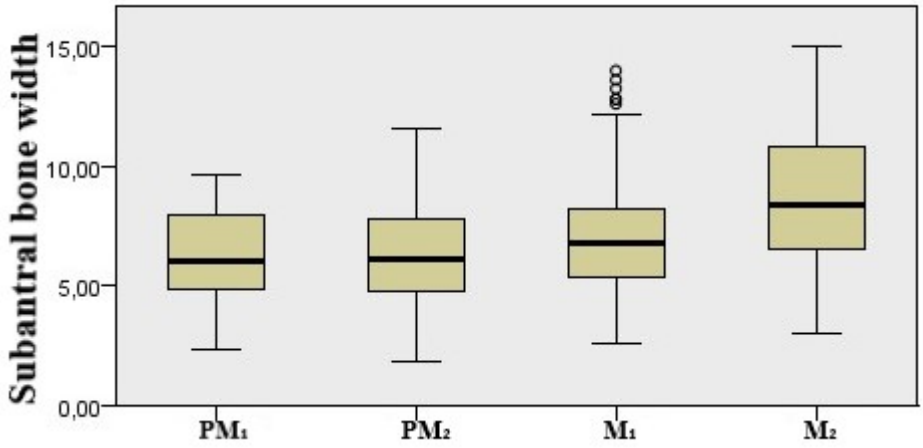

Figure 3

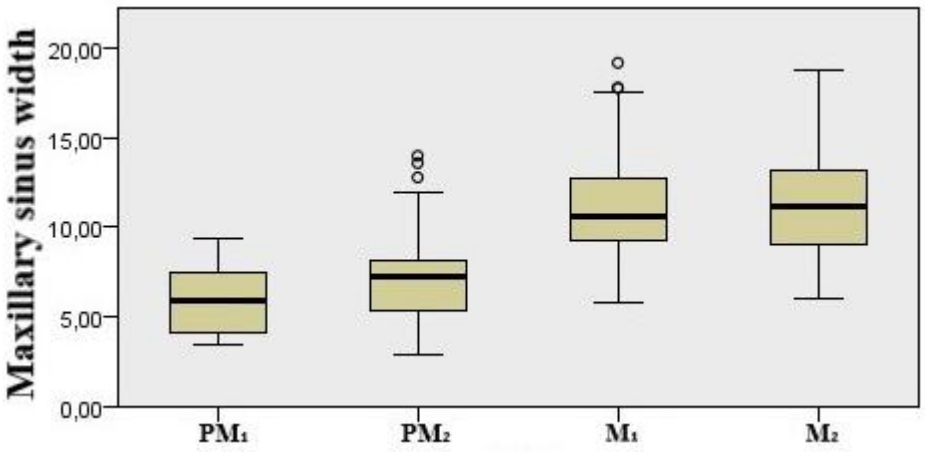

Figure 4

After the complete analysis of the data from the regions PM_1, PM_2, M_1 и M_2, significant inverse reation was found between MSW and SBH p<0, 01. Between MSW and SBW, there was a significant direct relation p<0.01.

4. Discussion

There is a proportional relationship between the number of bone defect walls involved in the augmentation process and the number of osteogenic cells available (4, 10, 17).

MSFA is the most commonly used procedure for the permanent creation of the necessary level of the subantral bone for the placement of dental implants with a conventional length of 8 mm in the distal parts of the maxilla. The procedure has been used for almost 40 years in implant surgery and has high predictability for the success of implant treatment (22).

Factors that favor the success of the maxillary sinus floor augmentation are still under discussion (14).

In recent years, attention has been paid to the morphology of the MS and, in particular, its width in the vestibular-palatal direction, taking into account the distance between the medial and lateral walls of the maxillary sinuses. In addition, attempts have been made to develop a classification of MS to support the preoperative planning of the augmentation procedure to choose an approach suitable for bone repair material (6, 21).

Bertl et. al. (3) argue that MSW is a relevant factor for graft consolidation in MSFA. They investigated the possibility of compiling an accessible and clinically relevant classification of MS based on its width in the vestibular-palatal direction, taking into account the distance between the medial and lateral walls of MS. Still, due to the large variation of MSW, the authors conclude that the creation of an accessible and meaningful classification of MSis not possible. They found that MSW in the vestibular-palatal direction was associated with SBW and SBH.
Several publications report an inverse relationship between the percentage of newly formed bone after the MSFA augmentation procedure and its width, taking into account the distance between the medial and lateral walls of the MS in the vestibular-lateral ridge of the alveolar ridge (2, 12, 18, 19).

To prepare a specification for subantral deficiency, 76 preoperative CBCTs were considered in patients with MSFA augmentation procedure with lateral approach, and a total of 108 MS were monitored, with a total of 305 missing teeth identified. On each of the 305 missing teeth the parameters SBH, SBW, and MSW were measured. The latter parameter was selected to be measured at 8 mm from the ridge of the alveolar ridge, according to the literature, for an inversely proportional relationship between the percentage of newly formed bone after the MSFA augmentation procedure and its width (2, 12, 18, 19), also we took into account the fact that this is the minimum height required for the placement of a conventional length implant.

By preparing the specification of the subantral deficit of cases with MSFA, we confirmed the connection of SBH, SBW and MSW established by Bertl and associates, establishing significant feedback between MSW and SBH p<0.01, and between MSW and SBW, there is a significant direct relationship p<0.01. In addition, we found that SBH decreased from the premolar to the molar area, and SBW and MSW increased from the premolar to the molar area.

5. Conclusion

Our study describes the trends in the size of SBH, SBW and MSW. We believe that our results could be helpful for future clinical researches to establish a relationship between SBW and MSFA procedure success, as there are already studies looking for a relation between MSW and MSFA procedure success.

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Application:

Table 1

	Researched criteria	n observed region	Mean	SD	Median	Q_1	Q_3	IQR	Range	Min	Max
region PM_1	SBH	39	10.80mm	3.31	x	x	x	x	12.90mm	4.31mm	17.21mm
	SBW	39	6.27mm	2.07	x	x	x	x	7.34mm	2.33mm	9.67mm
	MSW	8	5.98mm	2.31	x	x	x	x	6.00mm	3.40mm	9.40mm
region PM_2	SBH	69	x	x	6.12mm	4.50mm	7.61mm	3.11mm	16.93mm	1.61mm	18.54mm
	SBW	69	6.28mm	2.02	x	x	x	x	9.81mm	1.80mm	11.61mm
	MSW	55	x	x	7.21mm	5.40mm	8.20mm	2.80mm	11.17mm	2.83mm	14.00mm
region M_1	SBH	108	x	x	3.20mm	2.20mm	4.60mm	2.40mm	5.80mm	1.00mm	6.80mm
	SBW	108	x	x	6.80mm	5.30mm	8.20mm	2.90mm	11.40mm	2.60mm	14.00mm
	MSW	108	x	x	10.60mm	9.26mm	12.75mm	3.49mm	13.40mm	5.80mm	19.20mm
region M_2	SBH	89	3.62mm	1.72	x	x	x	x	6.60mm	1.00mm	7.60mm
	SBW	89	8.50mm	2.78	x	x	x	x	12.00mm	3.00mm	15.00mm
	MSW	89	11.40mm	2.95	x	x	x	x	12.80mm	6.00mm	18.80mm

Table 2

	Researched criteria	n observed region	sex	Mean	SD	Median	Q_1	Q_3	IQR	Range	Min	Max	t	P
region PM_1	SBH	24	*male*	11.42mm	3.39	x	x	x	x	12.37mm	4.84mm	11.21mm	1.54	0.133
		15	*female*	9.81mm	3.02	x	x	x	x	11.29mm	4.31mm	15.60mm		
	SBW	24	*male*	6.83mm	2.08	x	x	x	x	7.26mm	2.41mm	9.67mm	2.31	0.027
		15	*female*	5.38mm	1.79	x	x	x	x	5.76mm	2.33mm	8.00mm		
	MSW	5	*male*	6.68mm	2.19	x	x	x	x	5.40mm	4.00mm	9.40mm	x	x
		3	*female*	x	x	x	x	x	x	x	x	x		
region PM_2	SBH	46	*male*	x	x	6.31mm	5.16mm	8.00mm	2.84mm.	16.54mm	2.00mm	18.54mm	x	0.024
		23	*female*	x	x	5.97mm	3.21mm	6.40mm	3.19mm	6.71mm	1.61mm	8.32mm		
	SBW	46	*male*	6.68mm	1.99	x	x	x	x	9.76mm	1.85mm	11.61mm	x	0.017
		23	*female*	5.48mm	1.87	x	x	x	x	6.61mm	1.80mm	8.41mm		
	MSW	33	*male*	x	x	7.80mm	5.60mm	8.60mm	3.00mm	10.00mm	4.00mm	14.00mm	x	0.151
		22	*female*	6.73mm	2.07	x	x	x	x	8.97mm	2.83mm	11.80mm		
region M_1	SBH	71	*male*	3.54mm	1,43	x	x	x	x	5.25mm	1.00mm	6.25mm	x	0.373
		37	*female*	x	x	3.00mm	2.00mm	5.20mm	3.20 mm	5.60mm	1.20mm	6.80mm		
	SBW	71	*male*	x	x	7.00mm	5.60mm	8.20mm	2.60mm	11.00mm	3.00mm	14.00mm	x	0.513
		37	*female*	6.73mm	2.51	x	x	x	x	9.01mm	2.60mm	11.61mm		
	MSW	71	*male*	x	x	10.40mm	9.00mm	12.60mm	3.60mm	13.39mm	5.81mm	19.20mm	x	0.327
		37	*female*	11.24mm	2.14	x	x	x	x	10.20mm	5.80mm	16.00mm		
region M_2	SBH	63	*male*	3.70mm	1.70	x	x	x	x	6.20mm	1.00mm	7.20mm	0.67	0.508
		26	*female*	3.43mm	1.79	x	x	x	x	6.60mm	1.00mm	7.60mm		
	SBW	63	*male*	9.02mm	2.64	x	x	x	x	11.19mm	3.81mm	15.00mm	2.79	0.008
		26	*female*	7.25mm	2.76	x	x	x	x	9.21mm	3.00mm	12.21mm		
	MSW	63	*male*	11.26mm	3.00	x	x	x	x	12.40mm	6.00mm	18.40mm	- 0.70	0.490
		26	*female*	11.74mm	2.87	x	x	x	x	12.20mm	6.60mm	18.80mm		

Table 3

	Researched criteria	n observed region	Age groups acc. WHO	Mean	SD	Median	Q_1	Q_3	IQR	Range	Min	Max	t	P
region PM_1	SBH	9	*15-44 / young age /*	10.23mm	2.85	x	x	x	x	9.27mm	6.23mm	15.50mm	x	0.062
		18	*45-59 / middle age/*	9.86mm	3.52	x	x	x	x	12.33mm	4.31mm	16.64mm		
		12	*60-74 /elderly/*	12.64mm	2.72	x	x	x	x	9.05mm	8.16mm	17.21mm		
	SBW	9	*15-44 / young age /*	5.33mm	1.94	x	x	x	x	5.59mm	2.41mm	8.00mm	x	0.003
		18	*45-59 / middle age/*	5.69mm	1.75	x	x	x	x	6.27mm	2.33mm	8.60mm		
		12	*60-74 /elderly/*	7.86mm	1.84	x	x	x	x	5.49mm	4.18mm	9.67mm		
	MSW	2	*15-44 / young age /*	x	x	x	x	x	x	x	x	x	x	x
		6	*45-59 / middle age/*	5.51mm	2.28	x	x	x	x	6.00mm	3.40mm	9.40mm		
		x	*60-74 /elderly/*	x	x	x	x	x	x	x	x	x		
region PM_2	SBH	17	*15-44 / young age /*	5.68mm	2.06	x	x	x	x	7.67mm	2.00mm	9.67mm	x	0.05
		35	*45-59 / middle age/*	5.68mm	2.17	x	x	x	x	8.99mm	1.61mm	10.60mm		
		17	*60-74 /elderly/*	x	x	7.44mm	5.36mm	8.00mm	2.64mm	14.94mm	3.60mm	18.54mm		
	SBW	17	*15-44 / young age /*	5.42mm	1.96	x	x	x	x	7.15mm	1.85mm	9.00mm	x	0.09
		35	*45-59 / middle age/*	6.37mm	1.97	x	x	x	x	8.60mm	1.80mm	10.40mm		
		17	*60-74 /elderly/*	6.94mm	2.01	x	x	x	x	7.76mm	3.85mm	11.61mm		
	MSW	15	*15-44 / young age /*	7.38mm	3.24	x	x	x	x	11.17mm	2.83mm	14.00mm	x	0.91
		30	*45-59 / middle age/*	7.35mm	2.18	x	x	x	x	10.18mm	3.42mm	13.60mm		
		10	*60-74 /elderly/*	x	x	7.20mm	5.85mm	7.80mm	1.95mm	7.58mm	5.22mm	12.80mm		
region M_1	SBH	31	*15-44 / young age /*	3.60mm	1.43	x	x	x	x	5.60mm	1.20mm	6.80mm	x	0.412
		57	*45-59 / middle age/*	3.32mm	1.58	x	x	x	x	5.00mm	1.00mm	6.00mm		
		20	*60-74 /elderly/*	3.73mm	1.38	x	x	x	x	4.45mm	1.80mm	6.25mm		
	SBW	31	*15-44 / young age /*	6.74mm	2.31	x	x	x	x	10.01mm	2.60mm	12.61mm	x	0.529
		57	*45-59 / middle age/*	6.95mm	2.55	x	x	x	x	9.80mm	3.00mm	12.80mm		
		20	*60-74 /elderly/*	x	x	7.20mm.	5.67mm	9.90mm	4.23mm	10.00mm	4.00mm	14.00mm		
	MSW	31	*15-44 / young age /*	10.94mm	2.39	x	x	x	x	10.20mm	5.80mm	16.00mm	x	0.506
		57	*45-59 / middle age/*	x	x	10.40mm	9.21mm	12.70mm	3.49mm	13.39mm	5.81mm	19.20mm		
		20	*60-74 /elderly/*	11.80mm	2.75	x	x	x	x	10.20mm	7.40mm	17.60mm		
region M_2	SBH	22	*15-44 / young age /*	3.35mm	1.65	x	x	x	x	5.60mm	1.00mm	6.60mm	0.58	0.562
		49	*45-59 / middle age/*	3.63mm	1.82	x	x	x	x	6.60mm	1.00mm	7.60mm		
		18	*60-74 /elderly/*	3.94mm	1.54	x	x	x	x	5.40mm	1.40mm	6.80mm		
	SBW	22	*15-44 / young age /*	8.03mm	2.62	x	x	x	x	9.00mm	3.00mm	12.00mm	0.83	0.439
		49	*45-59 / middle age/*	8.47mm	2.60	x	x	x	x	11.60mm	3.40mm	15.00mm		
		18	*60-74 /elderly/*	9.16mm	3.40	x	x	x	x	10.19mm	3.81mm	14.00mm		
	MSW	22	*15-44 / young age /*	8.84mm	2.92	x	x	x	x	10.80mm	6.20mm	17.00mm	0.39	0.678
		49	*45-59 / middle age/*	11.17mm	3.09	x	x	x	x	12.40mm	6.00mm	18.40mm		
		18	*60-74 /elderly/*	11.50mm	2.72	x	x	x	x	10.60mm	8.20mm	18.80mm		

Table 4

	Researched criteria	n observed region	Defect size	Mean	SD	Median	Q_1	Q_3	IQR	Range	Min	Max	t	P
region PM_1	SBH	4	PM_1-M_1	x	x	x	x	x	x	x	x	x	x	x
		37	PM_1- M_2	11.07mm	3.34	x	x	x	x	12.90mm	4.31mm	17.21mm		
	SBW	4	PM_1-M_1	x	x	x	x	x	x	x	x	x	x	x
		37	PM_1- M_2	6.15mm	2.15	x	x	x	x	7.34mm	2.33mm	9.67mm		
	MSW	1	PM_1-M_1	x	x	x	x	x	x	x	x	x	x	x
		7	PM_1- M_2	5.86mm	2.28	x	x	x	x	6.00mm	3.40mm	9.40mm		
region PM_2	SBH	7	PM_2- M_1			6.00mm	5.41mm	6.60mm	1.19mm	4.00mm	2.80mm	6.80mm		0.948
		4	PM_1-M_1	x	x	x	x	x	x	x	x	x	x	
		23	PM_2- M_2	x	x	6.12mm	4.60mm	6.75mm	2.15mm	16.54mm	2.00mm	18.54mm		
		35	PM_1- M_2	x	x	6.23mm	4.40mm	8.00mm	3.60mm	9.30mm	1.61mm	10.91mm	x	
	SBW	7	PM_2- M_1	6.23mm	1.42	x	x	x	x	3.40mm	4.60mm	8.00mm		0.325
		4	PM_1-M_1	x	x	x	x	x	x	x	x	x		
		23	PM_2- M_2	6.74mm	2.00	x	x	x	x	7.00mm	3.40mm	10.40mm		
		35	PM_1- M_2	5.89mm	2.18	x	x	x	x	9.81mm	1.80mm	11.61mm	x	
	MSW	7	PM_2- M_1	6.94mm	1.96	x	x	x	x	5.00mm	4.00mm	9.00mm		1
		4	PM_1-M_1	x	x	x	x	x	x	x	x	x		
		19	PM_2- M_2	7.58mm	2.95	x	x	x	x	10.58mm	3.42mm	14.00mm		
		25	PM_1- M_2	7.22mm	2.24	x	x	x	x	10.77mm	2.83mm	13.60mm	x	
region M_1	SBH	8	M_1	4.38mm	1.32	x	x	x	x	3.60mm	2.20mm	5.80mm		0.002
		7	PM_2- M_1	4.49mm	1.24	x	x	x	x	3.20mm	3.00mm	6.20mm		
		31	M_1-M_2	4.09mm	1.50	x	x	x	x	5.60mm	1.20mm	6.80mm		
		4	PM_1-M_1	x	x	x	x	x	x	x	x	x		
		23	PM_2- M_2	x	x	2.60mm	1.80mm	3.20mm	1.40mm	5.05mm	1.20mm	6.25mm		
		35	PM_1- M_2							5.00mm	1.00mm	6.00mm	x	
	SBW	8	M_1	6.65mm	1.67	x	x	x	x	5.00mm	3.80mm	8.80mm		0.798
		7	PM_2- M_1	7.49mm	1.94	x	x	x	x	5.40mm	5.20mm	10.60mm		
		31	M_1-M_2	6.98mm	1.91	x	x	x	x	9.40mm	3.40mm	12.80mm		
		4	PM_1-M_1	x	x	x	x	x	x	x	x	x		
		23	PM_2- M_2	7.22mm	2.39	x	x	x	x	9.20mm	3.00mm	12.20mm		
		35	PM_1- M_2	6.88mm	3.43	x	x	x	x	11.40mm	2.60mm	14.00mm	x	
	MSW	8	M_1	10.10mm	1.08	x	x	x	x	3.00mm	8.40mm	11.40mm		0.243
		7	PM_2- M_1	10.38mm	1.49	x	x	x	x	4.59mm	8.41mm	13.00mm		
		31	M_1-M_2	10.61mm	3.06	x	x	x	x	12.00mm	5.80mm	17.80mm		
		4	PM_1-M_1	x	x	x	x	x	x	x	x	x		
		23	PM_2- M_2	11.30mm	2.64	x	x	x	x	10.40mm	7.40mm	17.80mm		
		35	PM_1- M_2	11.90mm	2.85	x	x	x	x	11.20mm	8.00mm	19.20mm	x	
region M_2	SBH	31	M_1-M_2	3.61mm	1.47	x	x	x	x	5.80mm	1.00mm	6.80mm		0.243
		23	PM_2- M_2	4.10mm	1.83	x	x	x	x	5.40mm	1.60mm	7.00mm	1.43	
		35	PM_1- M_2	3.32mm	1.83	x	x	x	x	6.60mm	1.00mm	7.60mm		
	SBW	31	M_1-M_2	8.61mm	2.56	x	x	x	x	10.20mm	4.80mm	15.00mm		0.639
		23	PM_2- M_2	8.85mm	2.64	x	x	x	x	9.60mm	4.00mm	13.60mm	0.45	
		35	PM_1- M_2	8.17mm	3.07	x	x	x	x	11.00mm	3.00mm	14.00mm		
	MSW	31	M_1-M_2	11.16mm	3.04	x	x	x	x	12.20mm	6.20mm	18.40mm		0.416
		23	PM_2- M_2	10.95mm	2.80	x	x	x	x	12.40mm	6.00mm	18.40mm	0.88	
		35	PM_1- M_2	11.91mm	2.99	x	x	x	x	12.20mm	6.60mm	18.80mm		

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