Journal of Periodontal Medicine & Clinical Practice

Vol - 5, Issue - I, Jan - Apr 2018

www.jpmcp.com

Original Research

Evaluation of Schneiderian Membrane Thickness using Cone Beam Computed Tomography in Dentulous and Partially Edentulous Patients

Abbayya K[1], Disale P[2], Nayak A[3]

Abbayya K, Disale P, Nayak A. **Evaluation of Schneiderian Membrane Thickness using Cone Beam Computed Tomography in Dentulous and Partially Edentulous Patients** J Periodontal Med Clin Pract 2018;01:46-55

1. **Dr. KeshavaAbbayya (**Associate Professor, School of Dental Sciences, Krishna Institute of Medical Sciences Deemed University, Karad)
2. **Dr. PoojaDisale** (Post-graduate student, School of Dental Sciences, Krishna Institute of Medical Sciences Deemed University, Karad)
3. **Dr. Ajay Nayak** (Associate Professor, School of Dental Sciences, Krishna Institute of Medical Sciences Deemed University, Karad)

Abstract:

Objective: To determine the thickness of the Schneiderian membrane using cone beam computed tomography (CBCT) in dentulous and partially edentulous patients.

Material and methods: The study involved 200 patients (100 dentulous and 100 partially edentulous). CBCT scan was performed with respect to maxillary right and left first molar region. The measurements of the Schneiderian membrane were performed perpendicular to the bony sinus floor and ending of the mucosal surface shadow margin. The Schneiderian membrane thickness were correlated with age, gender and time elapsed since tooth extraction (in partially edentulous patients) in both maxillary right and left first molar region.

Results: The result of the study revealed that the thickness of schneiderian membrane increased with increasing age and with increase in time elapsed since tooth extraction. Gender correlation revealed significant increase in thickness of schneiderian membrane in male patients.

Conclusion: There is great interindividual variability in the thickness of the Schneiderian membrane with age, gender and time elapsed since tooth extraction.

Introduction

The rehabilitation of the edentulous area with endo-osseous dental implants has become an established and very common surgical procedure in dentistry.[1] While providing dental implants to patients who have lost upper posterior teeth a conceptual understanding of the anatomic and functional relationships between the maxillary sinus and upper posterior teeth is important.Bone volume in the edentulous posterior maxilla is frequently compromised by pneumatization combined with crestal bone resorption leaving thin alveolar bone or only mucoperiosteum (Schneiderian membrane) between the sinus floor and oral cavity.[2]Preprosthetic surgeries like alveolar bone grafting and sinus floor elevation was introduced to overcome this obstacle.[3, 4] Rotary instruments were first used to perform sinus elevation, [3] but nowdays, piezosurgey is the technique of choice.[5]Despite of evolved techniques complications still occur, like the presence of bony septa,[6] prior destructive maxillary sinus surgery

(e.g., Caldwell-Luc operation), and pathology such as acute rhinosinusitis or neoplastic processes[7]. The perforation of Schneiderian membrane (SM) being the most common complication, with the incidence rate of approximately 19.5%.[8]

Schneiderian membrane thickness (SMT) is an important anatomic landmark to be kept in mind while placing the maxillary implants. The thickness of the SM varies in different individuals[9] and also according to different age, gender and seasonal variations.[10]A reduced thickness of SM (due to pneumatization, recurrent sinusitis,etc.,) during implant placement could pose a risk for sinus membrane penetration or perforation[11] and subsequently leading to implant failure.[12]

To overcome the complications of SM perforation cone beam computed tomography (CBCT) is considered a gold standard for exploring paranasal sinuses before direct or indirect sinus floor elevation.[13] CBCT was shown to be effective in measuring the SM thickness.[10]

Thickness of the SM, shows the great interindividual variability with values ranging from 0.16mm (minimum) to 34.61mm (maximum).[10] The potential local or systemic factor influences the difference in thickness of the Schneiderian membrane. Hence, this study aims to investigate the Schneiderian membrane thickness in dentulous and partially edentulous patients.

Material And Methods

A total of 200 patients (100 dentulous and 100 partially edentulous) which included both males and females were involved in the study. The patients were referred for CBCT scan by their respective dentist at Insight CBCT Imaging Centre, Mumbai, India. The maxillary first molar region, both right and left was considered as a site of interest. These patients were subjected to a CBCT scan of the maxilla using iCAT17-19 next generation scanner (Imaging Sciences Internationalized, USA) at Insight CBCT Imaging Centre, Mumbai. The CBCT images of the respective areas was performed during the period between July 2017 and Jan 2018. Ethical clearance for the study was obtained from Krishna Institute of Medical Sciences deemed to be university, Karad.

A informed consent was obtained from the patients before commencing the study. The patients detailed histories were recorded. Patients having any history of sinus diseases, previous dental implacement or bone grafting were excluded from the study. The scan parameters were set at 5.0 to 7.0 mA, 80kV and exposure time of 26.9 seconds. The resolution of the scans was 0.25 mm voxels. The data reconstructed from the CBCT scans were evaluated using the iCAT-vision software by an experienced maxillofacial radiologist. 1mm slice intervals were used to evaluate the first molar region on the right and left sides of the maxillary arch in dentulous patients. The shadow of the soft tissue lining of the respective maxillary sinus floor was measured in mm at the slice in the center of the first molar region. (Figure 1)

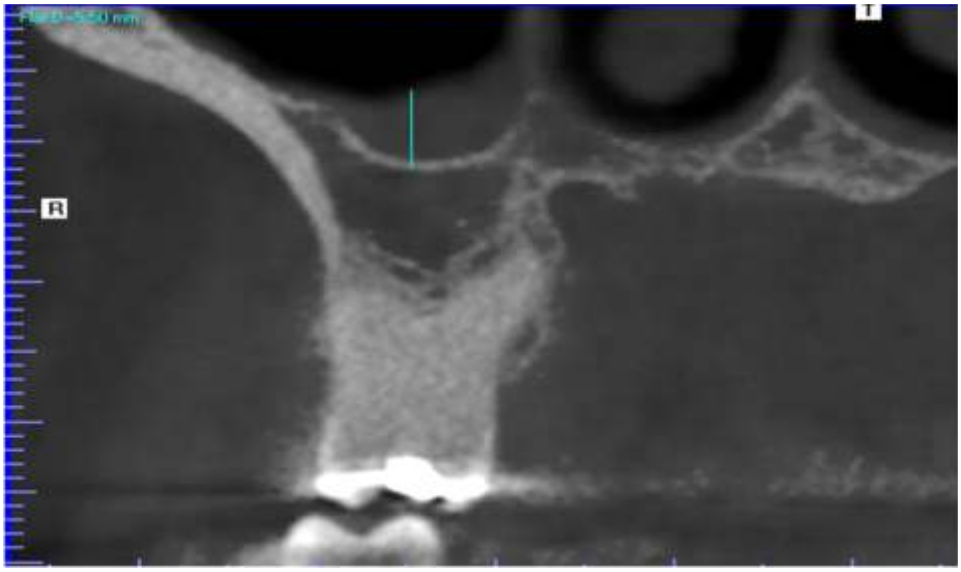

Figure 1: The measurement of the SM thickness in coronal CBCT slices in the center of the first molar region of dentulous patients

In the partially edentulous patients, the slices were evaluated from the distal surface of the second premolar upto the mesial surface of the second molar. The soft tissue floor lining was measured from the central slice the evaluated region. All these measurements of mucosal thickness were performed perpendicular to the bony sinus floor and ending of the mucosal surface shadow margin. (Figure 2)

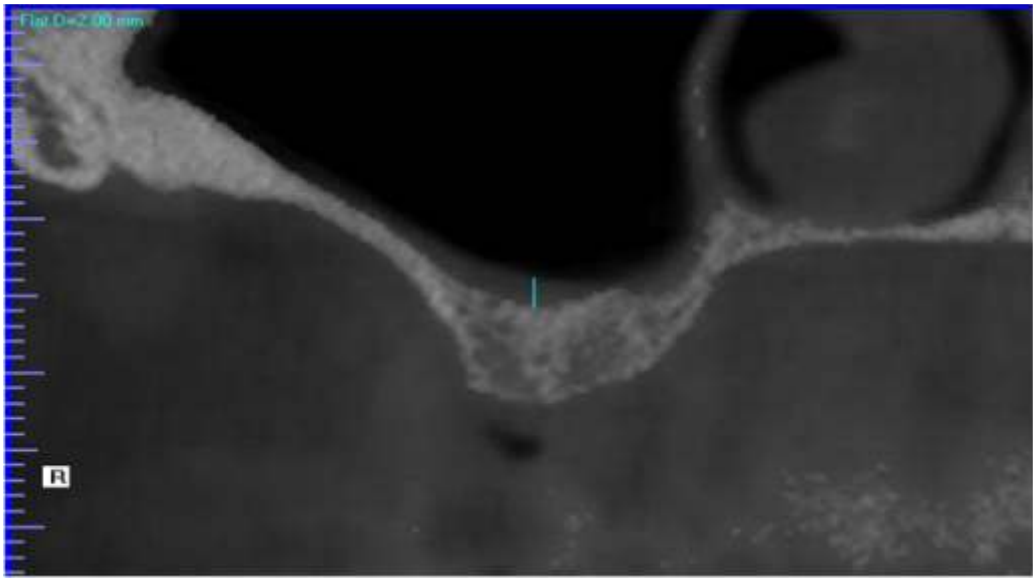

Figure 2: The measurement of the SM thickness in coronal CBCT slices in the center of the first molar region of partially edentulous patients.

The CBCT scans of 200 patients were evaluated to assess the Schneiderian membrane thickness in different age group, gender and time elapsed after tooth extraction in both maxillary right and left first molar region. In partially edentulous patients, depending on the time elapsed after tooth extraction three groups were made which involve Group 1: 0-4 years, Group 2: 4.1-8 years and Group 3: 8.1-12 years.

Statistical analysis

All data were first analyzed using statistical software SPSS windows version 20.0. Descriptive statistics for all parameters were expressed as mean ± SD, standard error of mean and intragroup comparison was performed using paired t tests with 95% confidence interval. Intergroup comparison were performed using unpaired t test.When significant di erence occurred, Mann-Whitney U test with Bonferroni correction was used for paired comparisons.Groups were compared by one-way analysis of variance, and the significance of the mean difference between the groups was done by Tukey*post hoc* test.

Results

The study population consisted of 100 dentulous patients (42 females, 58 males) averageage of 47.09±12.1 (range 24 to 75 years) and 100 partially edentulous patients (55 females, 45 males) average age of 46.05±16.1 (range 16 to 84 years).There was a wide range in the thickness of the SM as evaluated on the CBCT images, with a minimum value of 0.14mm & 0.1mm and a maximum value of 6.9 mm& 4.6mm in dentulous and partially edentulous patients respectively. Significant differences in SM thickness measurements were seen in dentulous and partially edentulous patients both maxillary right and left first molar region (Table 1).

Region	Sample Size	Mean ± Std. Deviation	Std. Error of Mean	Maximum	Minimum	P value	t value
Dentulous Maxillary right First molar region	100	2.85 ± 1.556	0.1556	6.9	0.14	<0.0001	6.689
Edentulous Maxillary right First molar region	100	1.67±0.8415	0.0841	4.6	0.3		
Dentulous Maxillary left First molar region	100	2.87± 1.464	0.1464	6.2	0.25	<0.0001	7.653
Edentulous Maxillary left First molar region	100	1.65±0.6293	0.0629	3.7	0.1		

A statistically significant influence on thickness of the Schneiderian membrane for gender was observed in both dentulous and partially edentulous patients. The SM thickness were generally higher for male subjects (Table 2).

Table 2: Analysis of potential influence of gender on the mean thickness of the SM(in mm) in dentulous and partially edentulous patients

Region	Group	Sample Size	Mean ± Std. Deviation	Std. Error of Mean	Maximum	Minimum	P value	t value
Maxillary right First molar region	Male	58	3.25 ± 1.418	0.1828±	6.9	0.18	0.004	3.023
	Female	42	2.34 ± 1.603	0.2474	6.4	0.14		
Maxillary left First molar region	Male	58	3.22 ± 1.409	0.1851	6.25	0.45	0.01	2.477
	Female	42	2.39 ± 1.413	0.2181	6.25	0.25		
Edentulous Maxillary right First molar region	Male	45	2.08±0.9420	0.1404	4.6	0.5	<0.0001	5.273
	Female	55	1.33±0.5637	0.0760	2.8	0.3		
Edentulous Maxillary left First molar region	Male	45	1.94±0.6309	0.094	3.7	0.8	0.0002	4.039
	Female	55	1.421±0.5238	0.0706	2.4	0.1		

While considering age related thickness of the Schneiderian membrane, there is a significant increase in thickness age more than 40 years in both dentulous and partially edentulous patients with mean values 3.33 ± 1.397 and 1.9±0.9410 respectively (Table 3).

Table 3: Analysis of potential influence of age on the mean thickness of the SM(in mm) in dentulous and partially edentulous patients

Region	Age Group	Sample Size	Mean ± Std. Deviation	Std. Error of Mean	Maximum	Minimum	P value	t value
Dentulous Maxillary right First molar region	20-40 yrs	29	1.70 ± 1.307	0.242	4.6	0.14	0.001	3.675
	≥40yrs	71	3.33 ± 1.397	0.167	6.9	0.38		
Dentulous Maxillary left First molar region	20-40 yrs	29	1.98± 1.454	0.26	6.25	0.25	0.02	2.459
	≥40yrs	71	3.24 ± 1.310	0.15	6.25	0.53		
Edentulous Maxillary right First molar region	20-40 yrs	24	1.33±0.5277	0.0824	2.6	0.3	0.0341	2.194
	≥40yrs	76	1.9±0.9410	0.1225	4.6	0.3		
Edentulous Maxillary left First molar region	20-40 yrs	24	1.49±0.4472	0.069	2.4	0.5	0.0435	2.088
	≥40yrs	76	1.77±0.7112	0.095	3.7	0.1		

In partially edentulous patients, thickness of the SM varies with time elapsed after tooth extraction. The thickness of the SM decreases with the increase in time period after the tooth removal (Table 4).

Table 4: Comparison of mean difference in thickness of the SM in different time period by Tukey post hoc test in partially edentulous patients
CI – Confidence interval; *q* – Studentised range statistic, *(p*≤0.001 Highly significant)

Region	Comparisons	Mean difference	q value	P value	95% CI of different
Edentulous maxillary right first molar region	Group 1 vs Group 2	3.864	16.386	<0.001	3.069-4.659
	Group 1 vs Group 3	7.297	30.865	<0.001	6.500-8.095
	Group 2 vs Group 3	3.434	21.435	<0.001	2.893-3.974
Edentulous maxillary right first molar region	Group 1 vs Group 2	3.813	18.662	<0.001	3.124-4.659
	Group 1 vs Group 3	7.039	31.681	<0.001	6.290-7.788
	Group 2 vs Group 3	3.227	19.743	<0.001	2.675-3.778

The current study statistically revealed an increase in thickness of SM as age and time elapsed after tooth removal advances and with a higher prevalence of thickness in male patients.

Discussion

Preoperative evaluation of maxillary sinus in 3D imaging is highly clinically relevant for the detection of sinus variations, Schneiderian membrane thickness and sinus pathologies. The modified treatment and the outcome of preprosthetic surgery in posterior maxilla can become more predictable with the help of CBCT. All treatments concerned with augmentation procedure should have sufficient knowledge of the maxillary sinus anatomy and pathology. However there is limited understanding of the significance of the SM thickness variations, and there is no guidelines for assessment and classification of findings in the sinus membrane.[10,14]

Schneiderian membrane is unique lining of the nasal cavity and paranasal sinuses, attached to the bordering bone of the maxillary sinus. The periosteum is overlaid with an ectodermally derived ciliated columnar epithelium with goblet cells.These cells constitutes an important barrier for the protection and defence of the sinus cavity. Its integrity is important to maintain the health of normal function of the sinus.Loss of normal mucociliary apparatus function and loss of the biologic barrier owing to perforation of the membrane can increase sinus bacteria invasion and infection.[15,16]The SM perforation is most common complication of sinus augmentation, with a reported rate from 10 to 55%.[17,11] Perforations can occur from operator error, anatomic variations such as the presence of septae, thin membranes, sinus pathology, previous entrance into the sinus, and overfilling at the time of graft placement.[18] Although individual variability in the homogeneity and viscoelasticity of mucosa might also lead to

membrane perforation.[19] Furthermore, thickness of SM may vary with different sinus location.[10]

In the present study, SM thickness was measured with CBCT in the centre of the first molar region.The thickness of the SM as evaluated on the CBCT images, revealed a wide range with a minimum value of 0.14mm & 0.1mm and a maximum value of 6.9 mm & 4.6mm for dentulous and partially edentulous patients respectively. Multiple studies have shown large intervariability in SM thickness. Tos&Mogensen (1979) evaluated SM thickness in 10 unfixed, fresh postmortem cadavers without any signs of sinusitis and found mean values ranging from 0.3 to0.8mm.[20] Pommeret al. (2009), found a mean thickness value ranging from 0.09-0.05mm (range 0.02–0.35mm) in 20 fresh cadavers.[21] Similarly, Aimetti et al. (2008), measured a mean thickness SM is ranging from 0.97 -0.36mm while analyzing sinus biopsies from healthy subjects.[22] A wide range SM thickness was observed by Janner et al. (2011), with a minimum value of 0.16mm and a maximum value of 34.61 mm. The highest mean values, ranging from 2.16 to 3.11 mm, were found for the mucosa located in the mid-sagittal regions of the maxillary sinus. Seasonal variations such as winter, spring, summer, autumn is also thought to be influencing the thickness of the Schneiderian membrane.[10]

While comparing male and female SM thickness in the current study, the respective mean values were generally higher for male subjects (3.25 ± 1.418) & (2.08±0.9420) than female subjects (2.34 ± 1.603) & (1.33±0.5637) for dentulous and partially edentulous patients respectively. These results are in accordance with a study by Janner et al. (2011) while considering additional anamnestic parameters such as age, gender, tobacco use, known rhinologic disease and weeks since last tooth/teeth removal in the examined maxillary segment.[10] Gender seems to be the most important parameter influencing mucosal thickness in asymptomatic patients with male subjects having higher mean values.[10] In contrast, a study done by Shanbang et al. (2014) found no influence of gender on SM thickness.[23]

The present study showed the increase in thickness of SM with age in both dentulous and partially edentulous patients. Similar results were obtained by Shanbang et al. (2014), in which he found older patients presenting thicker SM than younger patients.[23]

In partially edentulous patients, thickness of SM while comparing with time elapsed after tooth removal is decreases with increase in time and the similar results was observed in study by Janner et al. (2011).[10]

Conclusion:

The current cross-sectional study demonstrated varying thickness of SM since there are many factors influencing SM thickness. Thus further longitudinal follow-up studies are required to prove the changes in SMT according to seasonal variation, inflammatory status and tobacco cessation. Thus, the clinician needs to have a through information and knowledge of SMT prior to placing implants or bone grafts so as to avoid further surgical complications.

References

1. Zarb GA, Albrektsson T. Tissue-Integrated Prostheses:Osseointegration in clinical Dentistry. Chicago:Quintessence,1985.
2. Misch CE, Judy KW. Classification of partially edentulous arches for implant dentistry. Int J Oral Implantol 1987;4;7-13.
3. Boyne PJ, James RA. Grafting of the maxillary sinus floor with autogenous

marrow and bone. J Oral Surg1980;38:613-616.

4. Watzek G, Weber R, Bernhart T, Ulm C, Haas R. Treatment of patients with extreme maxillary atrophy using sinus floor augmentation and implants: Preliminary results. Int J Oral MaxillofacSurg 1998;27: 428-434.
5. Vercellotti T, De Paoli S, Nevins M. The piezoelectric bony window osteotomy and sinus membrane elevation: Introduction of a new technique for simplification of the sinus augmentation procedure. Int J Periodontics Restorative Dent 2001;21:561-567.
6. Naitoh, M., Suenaga, Y., Kondo, S., Gotoh, K. &Ariji, E. (2009) Assessment of maxillary sinus septa using cone-beam computed tomography: etiological consideration. Clinical Implant Dentistry & Related Research 11 (Suppl. 1): e52–e58.
7. Van den Bergh, J.P., ten Bruggenkate, C.M., Disch, F.J. &Tuinzing, D.B. (2000) Anatomical aspects of sinus floor elevations. Clinical Oral Implants Research 11: 256–265.
8. Pjetursson BE, Tan WC, Zwahlen M, Lang NP. A systematic review of the success of sinus floor elevation and survival of implants inserted in combination with sinus floor elevation. J ClinPeriodontol 2008; 35(Suppl. 8):216-240.
9. Dobele I, Kise L, Apse P, Kragis G, Bigestans A. Radiographic assessment of findings in the maxillary sinus using cone-beam computed tomography. Stomatologija. 2013; 15: 119–122.
10. Janner SFM, Caversaccio MD, Dubach P, Sendi P, Buser D, Bornstein MM. Characteristics and dimensions of the Schneiderian membrane: A radiographic analysis using cone beam computed tomography in patients referred for dental implant surgery in the posterior maxilla. Clin Oral Implants Res 2011;22:1446-1453.
11. Schwartz-Arad D, Herzberg R, Dolev E: The prevalence of surgical complications of the sinus graft procedure and their impact on implant survival. J Periodontol 75:511, 2004
12. Cho-Lee GY, Naval-Gias L, Castrejon-Castrejon S, et al. A 12-year retrospective analytic study of the implant survival rate in 177 consecutive maxillary sinus augmentation procedures. Int J Oral Maxillofac Implants 2010;25:1019-1027.
13. Harris D, Horner K, Grondahl K, et al. EAO guidelines for the use of diagnostic imaging in implant dentistry 2011. A consensus workshop organized by the European Association for Osseointegration at the Medical University of Warsaw. Clin Oral Implants Res 2012;23:1243-1253.
14. Schneider AC, Brager U, Sendi P, Caversacio MD, Busre D, Bornstein MM. Characteristics and dimensions of the sinus membrane in patients referred for single–implant treatment in the posterior maxilla: a cone beam computed tomographic analysis. Int J Oral Maxillofac Implants 2013;28:587–96.
15. Zijderveld SA, Bergh van den JPA, Schulten E, et al: Anatomicaland surgical findings and complications in 100 consecutive maxillary sinus floor elevation procedures. J Oral MaxillofacSurg 66:1426,

2008.

16. Proussaefs P, Lozada J, Kim J, et al: Repair of the perforated sinusmembrane with a resorbable collagen membrane: A human study. Int J Oral Maxillofac Implants 19:413, 2004.
17. C.E. Misch. The maxillary sinus lift and sinus graft surgery C.E. Misch (Ed.), Contemporary Implant Dentistry, CV Mosby, St Louis, MO (1999), pp. 469-495.
18. MischK, Wang HL: Implant surgery complications: Etiology andtreatment. Implant Dent 17:159, 2008.
19. J. Chen, R. Ahmad, W.Li, M.Swain, and Q. Li,"Biomechanics of oral mucosa," Journal of the Royal Society Interface, vol.12, no. 109, Article ID 20150325,2015.
20. Tos, M. &Mogensen, C. (1979) Mucus production in the nasal sinuses. ActaOto-Laryngologica 360:131–134.
21. B. Pommer, E. Unger, D. Sütö, *et al.* Mechanical properties of the Schneiderian membrane in vitro.Clin Oral Implants Res, 20 (2009), p. 633.
22. Aimetti M, Massei G, Morra M, Cardesi E, Romano F. Correlation between gingival phenotype and Schneiderian membrane thickness. Int J Oral Maxillofac Implants 2008;23:1128–1132.
23. Shanbhag S, Karnik P, Shirke P, Shanbhag V. Cone-beam computed tomographic analysis of sinus membrane thickness, ostium patency, and residual ridge heights in the posterior maxilla: Implications for sinus floor elevation. Clin Oral Implants Res. 2014;25(6):755–60.

Competing interest / Conflict of interest The author(s) have no competing interests for financial support, publication of this research, patents and royalties through this collaborative research. All authors were equally involved in discussed research work. There is no financial conflict with the subject matter discussed in the manuscript.
Source of support: NIL