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Correlation of Maxillary Sinus to the Roots of Maxillary Posterior Teeth and a Review of Literature

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Abstract: ***An anatomical description and relationship between the root apex of the maxillary tooth and the inferior wall of the maxillary sinus are essential for diagnosing sinus pathoses and planning a proper dental implantation. Therefore identifying the degree of proximity as well as the cortical thickness between the root apex and the inferior wall of the sinus is useful for surgical procedures.***

Keywords: Maxillary sinus, Maxillary posterior teeth, Extraction complications, Orthodontics, Radiographic

1. Introduction

The maxillary sinus is the largest of all the paranasalsinuses; at 10 weeks in utero is the first to develop. After birth sinus continues to pneumatize into the developing alveolar ridge as the permanent teeth erupt. At 12-13 years the sinus floor is level with nasal floor and at age 20, with completion of eruption of the 3rd molar, the pneumatization of the sinus ends.[1]

The adult sinus is variable in its extensions. Its floor extends between adjacent teeth or between individual in about half the population, creating elevations in the antral surface (commonly referred to as hillocks) or protrusions of the root apices into sinus. Histological sections show that the most of the roots that protrude radiographically into sinus are actually enveloped by a thin cortical layer with perforation in 14% to 28% of the cases.[2]

An anatomical description and relationship between the root apex of the maxillary tooth and the inferior wall of the maxillary sinus are essential for diagnosing sinus pathoses and planning a proper dental implantation. Therefore identifying the degree of proximity as well as the cortical thickness between the root apex and the inferior wall of the sinus is useful for surgical procedures.[3]

Tooth roots that protrude into the maxillary sinus can have various implications, including the following.

1) **Implants.**Wehrbein and diedrich described a positive correlation between the length of the root projection on the maxillary sinus in panoramic radiograph and the amount of pneumatization after extraction. Sinus expansion after extraction can greatly decrease the bone height available for the implant placement.
2) **Extraction complication.**Oroantral fistulae or root displacement into the sinus cavity are a frequent complications after extraction of the first and second molars.
3) **Endo antral syndrome.** In endoantral syndrome, the spread of pulpal disease beyond the confines of the dental supporting tissues into the maxillary sinus causing sinusitis may be present.
4) **Orthodontics**. Intrusion or bodily movement of the teeth across the sinus floor by orthodontic treatment have been shown to cause moderate apical root resorption and higher degree of tipping.[2]

2. Aims and Objectives

The aim of the study was to investigate the relationship of the posterior tooth to the maxillary antrum and to assess any correlation in comparison of the right side to the left side of the patient, and between the male and female patients.

3. Materials and Methods

In this study paranomic radiographs were selected from dental records of the patients who completed dental treatment at the department of oral and maxillofacial surgery, MeenakshiAmmal Dental College, Chennai. The ethical committee of MAHER University has approved the study design.

The study sample size includes a total of 150 subjects; both male and female are included in the study with an age ranging from 12 – 60 yrs.

A total of 150 paranomic radiographs were collected and the sinus lining and the root tips of the posterior tooth are traced on them. Perpendicular lines are drawn connecting the deepest point of the maxillary sinus floor to the root rips of the maxillary first and second premolars and molars, and the distances were measured and noted down.[4]

Diagrammatic representation of the method

The radiographic images were grouped according to the relationship between the root tips and the maxillary sinus lining as follows:
Group 1: root tips in contact with sinus floor
Group 2: root tips penetrating into the sinus floor
Group 3: root tips below the sinus floor.

Distances were measured for each tooth and individual roots on either side. Root tips in group 1 were numbered 0, those in group 2 were given positive number and those in group 3 were given negative number. Mean, standard deviation and minimum and maximum valves were calculated for all right and left premolar and molars.

4. Results

The total number of patients included in the this study was 150.

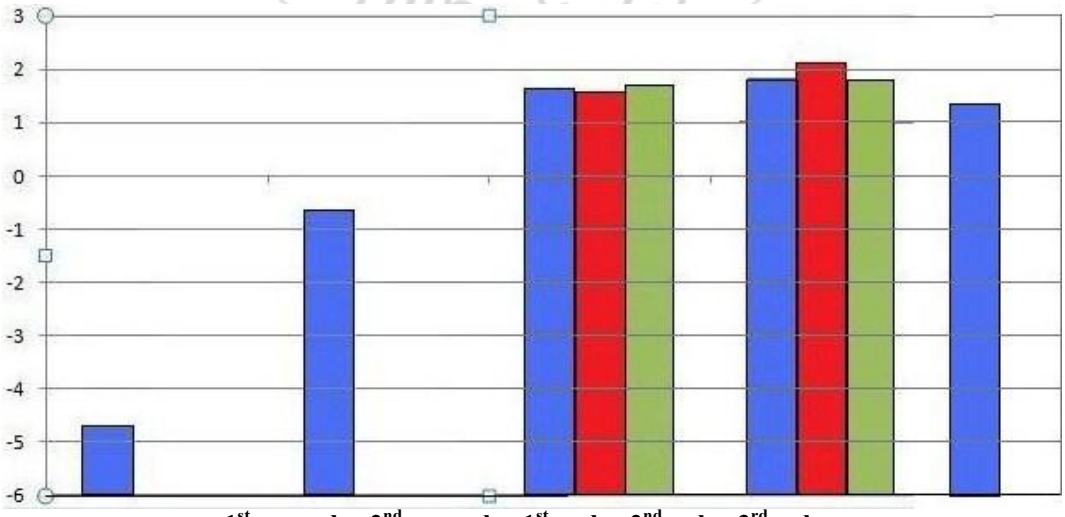
Gender:
In our study the male to female ratio was 1:1.2

Patient	*Percentage*	*Frequency*
Male	42	63
Female	58	87

Age:
The mean age of the patients in the study was 22 years ranging from 12 – 60 yrs.
Mean, standard deviation and the minimum and maximum values in comparison of the right and left sides is given in the table below:

Right side

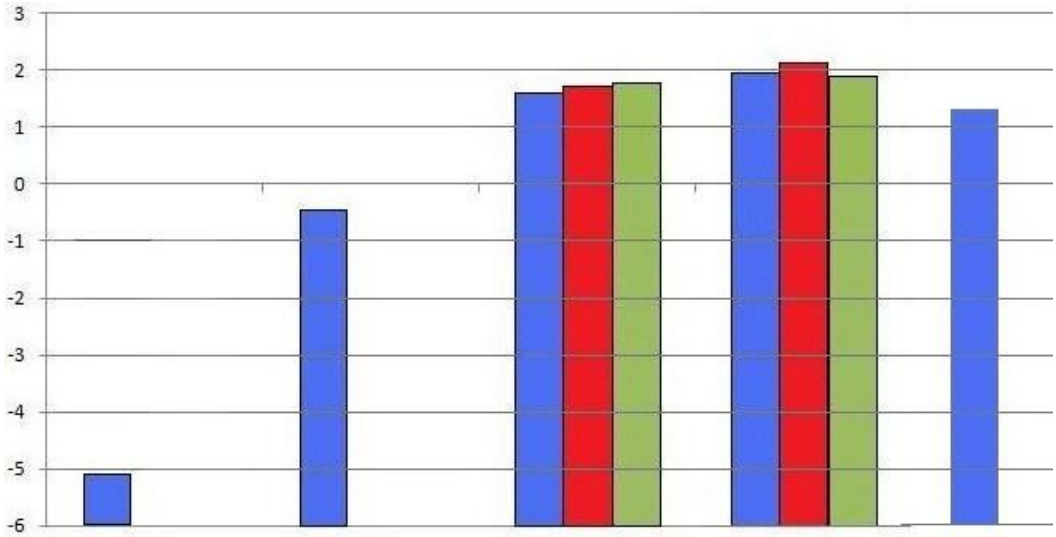
Tooth	*N*	*Mean*	*Standard deviation*	*Minimum*	*Maximum*
1st premolar	142	-4.75	5.782	-20	+5
2nd premolar	148	-0.66	3.884	-20	+4
1st molar mesiobuccal	149	1.66	2.514	-10	+7
1st molar distobuccal	149	1.58	2.099	-9	+6
1st molar palatal	149	1.73	2.410	-8	+6
2nd molar mesiobuccal	150	1.86	2.00	-6	+7
2nd molar distobuccal	150	2.13	2.112	-5	+7
2nd molar palatal	150	1.83	2.123	-4	+7
3rd molar	121	1.32	2.121	-5	+6



1st premolar 2nd premolar 1st molar 2ndmolar 3rdmolar
0 corresponds to the level of the sinus

Left side

Tooth	*N*	*Mean*	*Standard deviation*	*Minimum*	*Maximum*
1st Premolar	142	-5.09	5.476	-20	+4
2nd Premolar	149	-0.45	3.991	-18	+6
1st molar mesiobuccal	148	1.62	2.346	-7	+6
1st molar distobuccal	148	1.72	2.195	-6	+7
1st molar palatal	148	1.78	2.604	-5	+7
2nd molar mesiobuccal	150	1.98	1.926	-7	+6
2nd molar distobuccal	150	2.15	2.429	-7	+9
2nd molar palatal	150	1.90	2.062	-9	+7
3rd molar	128	1.28	2.012	-4	+6



1st premolar 2nd premolar 1st molar 2nd molar 3rd molar
0 corresponds to the level of the sinus

Mean, standard deviation and the minimum and maximum values in comparison of the male to female Patients is given in the table below:

Male

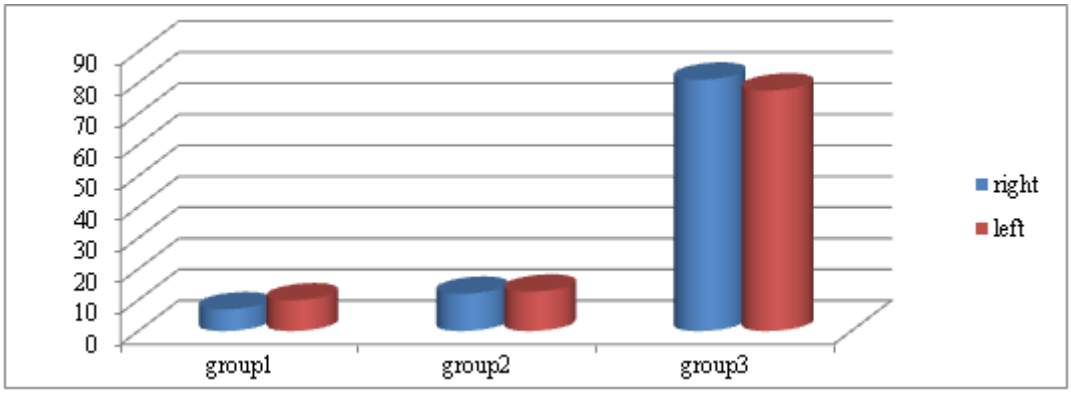
Tooth	*N*	*Mean*	*Standard deviation*	*Minimum*	*Maximum*
1st Premolar	122	-4.30	5.315	-20	+4
2nd Premolar	126	-0.15	3.306	-10	+4
1st molar mesiobuccal	125	1.87	2.413	-7	+7
1st molar distobuccal	125	1.93	1.927	-6	+6
1st molar palatal	125	1.85	2.547	-8	+7
2nd molar mesiobuccal	126	1.92	1.814	-6	+7
2nd molar distobuccal	126	2.25	2.373	-5	+9
2nd molar palatal	126	1.98	1.822	-6	+7
3rd molar	108	1.21	2.327	-5	+6

Female

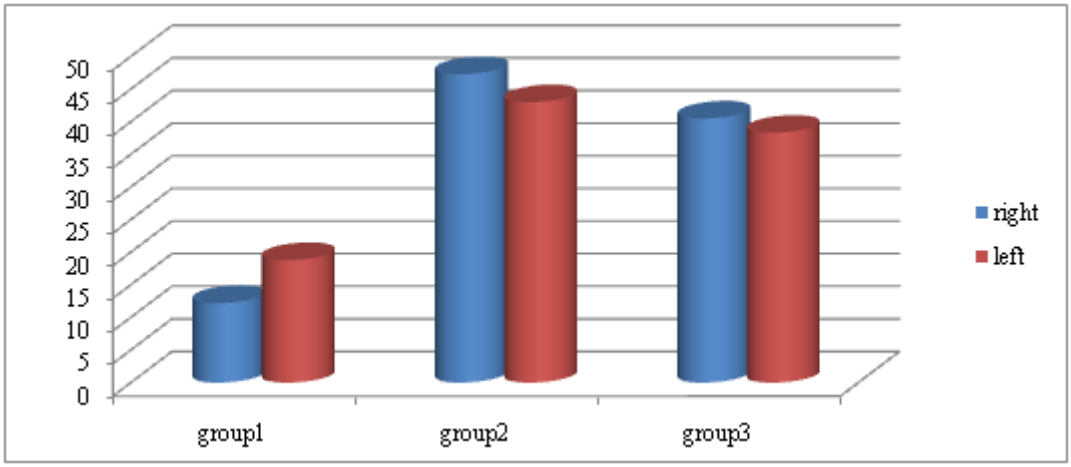
Tooth	*N*	*Mean*	*Standard deviation*	*Minimum*	*Maximum*
1st Premolar	162	-5.39	5.818	-20	+5
2nd Premolar	171	-0.85	4.322	-20	+3
1st molar mesiobuccal	172	1.48	2.431	-10	+6
1st molar distobuccal	172	1.44	2.274	-9	+7
1st molar palatal	172	1.69	2.479	-5	+6
2nd molar mesiobuccal	174	1.92	2.067	-7	+6
2nd molar distobuccal	174	2.05	2.199	-7	+7
2nd molar palatal	174	1.78	2.265	-9	+7
3rd molar	141	1.37	2.212	-4	+6

The distance between the sinus floor and the root tip was longest for the first Premolar root tip, followed by the second Premolar root tip. The distance between the sinus floor and the root tip was shortest for the distobuccal root of the second molar, followed by the mesiobucal root tip of the second molar for both right and left sides. Statically no significant differences were found between the measurements for the right and left sides or between the male and female Patients (P>0.05)

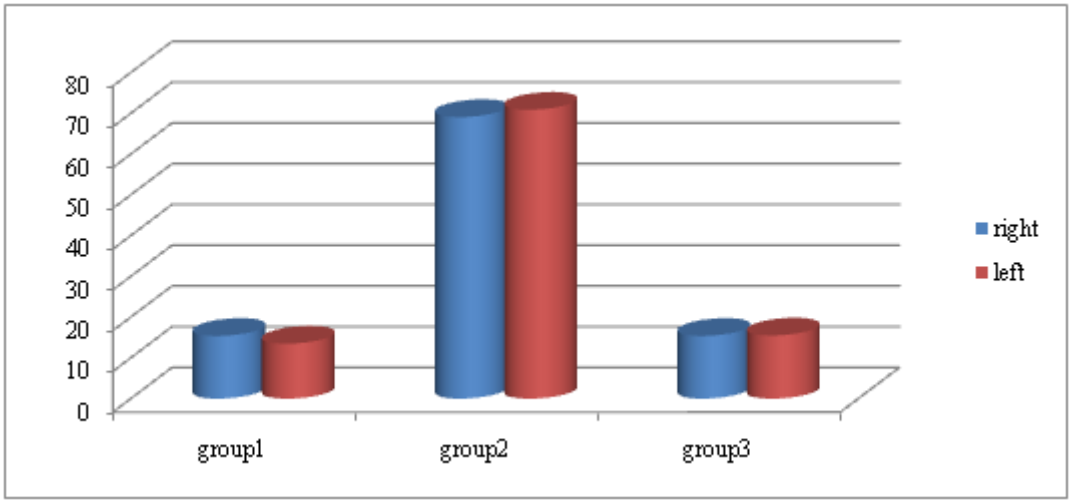
1st premolar	Side				Total	
	Right		Left			
	N	%	N	%	N	%
Group 1	10	7	14	9.9	24	8.5
Group 2	17	12	18	12.7	35	12.3
Group 3	115	81	110	77.5	225	79.2
Total	142	100	142	100	284	100



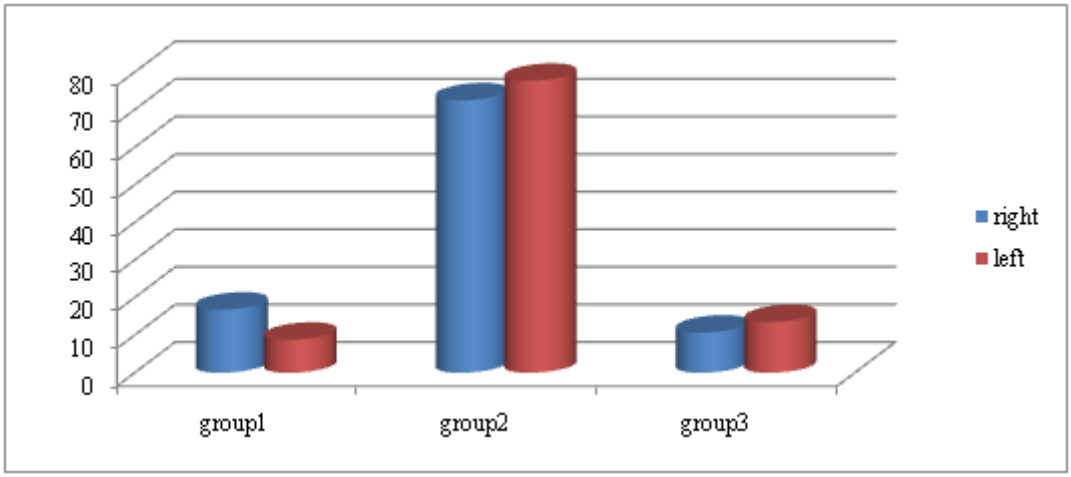
2nd premolar	Side				Total	
	Right		Left			
	N	%	N	%	N	%
Group 1	18	12.2	28	18.8	46	15.5
Group 2	70	47.3	64	43	134	45.1
Group 3	60	40.5	57	38.3	117	39.4
Total	148	100	149	100	297	100



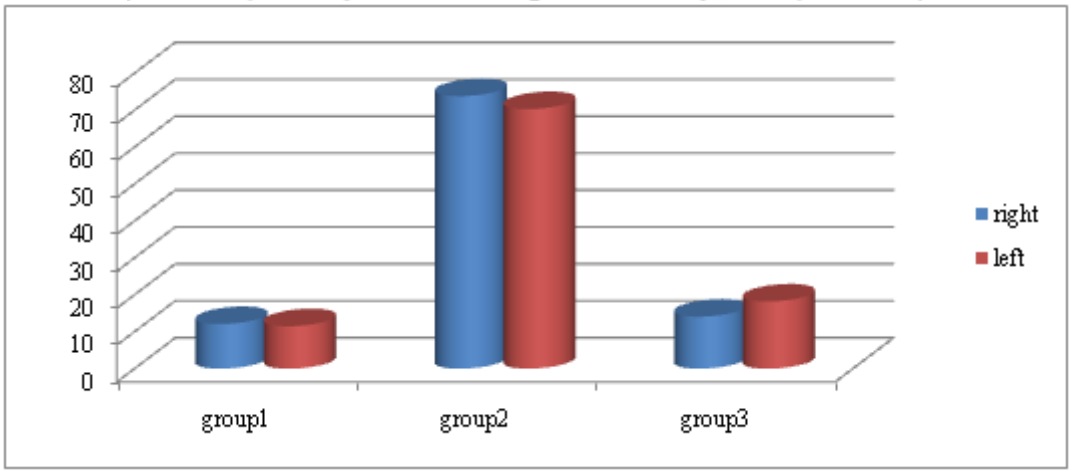
1st molar mesiobuccal root	Side				Total	
	Right		Left			
	N	%	N	%	N	%
Group 1	23	15.4	20	13.5	43	14.5
Group 2	103	69.1	105	70.9	208	70
Group 3	23	15.4	23	15.5	46	15.5
Total	149	100	148	100	297	100



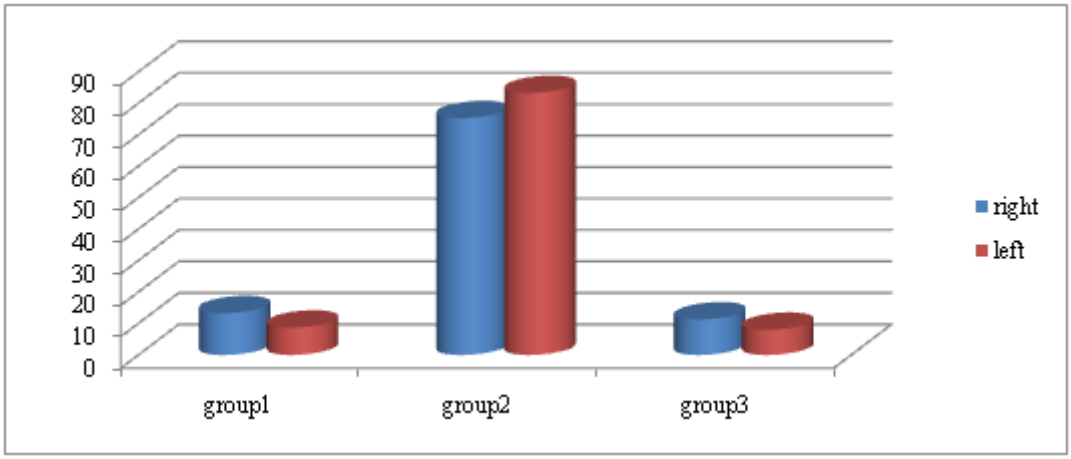
1st molar distobuccal root	Side				Total	
	Right		Left			
	N	%	N	%	N	%
Group 1	25	16.8	13	8.8	38	12.8
Group 2	108	72.5	115	77.7	223	75.1
Group 3	16	10.7	20	13.5	36	12.1
Total	149	100	148	100	297	100



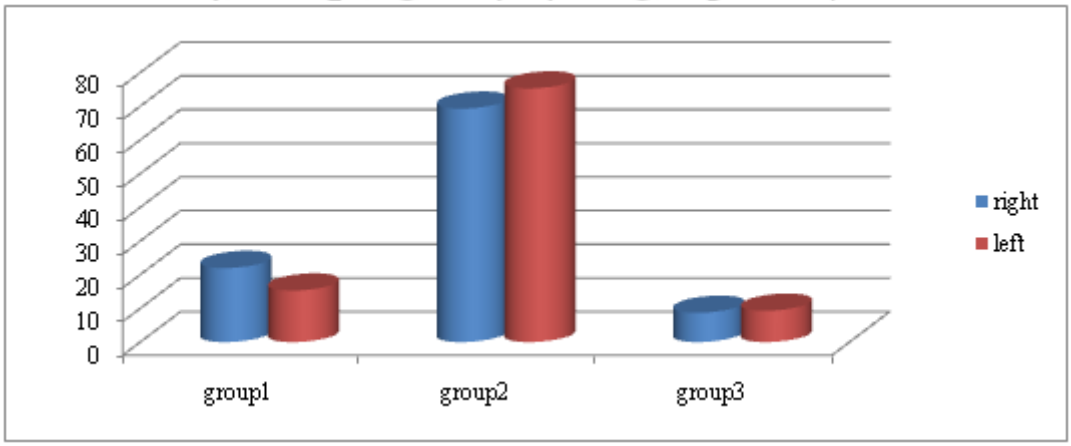
1st molar palatal root	Side				Total	
	Right		Left			
	N	%	N	%	N	%
Group 1	18	12.1	17	11.5	35	11.8
Group 2	110	73.8	104	70.3	214	72.1
Group 3	21	14.1	27	18.2	48	16.2
Total	149	100	148	100	297	100



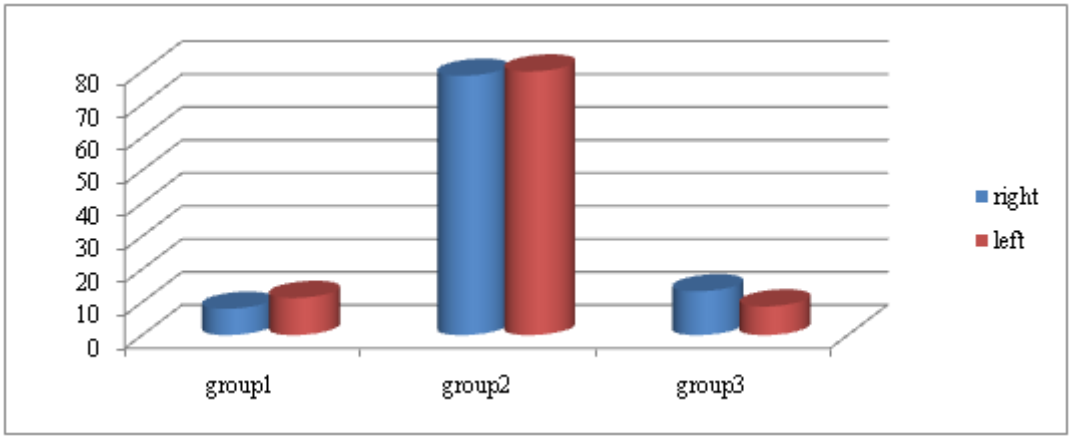
2nd molar mesiobuccal root	Side				Total	
	Right		Left			
	N	%	N	%	N	%
Group 1	20	13.3	13	8.7	33	11
Group 2	113	75.3	125	83.3	238	79.3
Group 3	17	11.3	12	8	29	9.7
Total	150	100	150	100	300	100



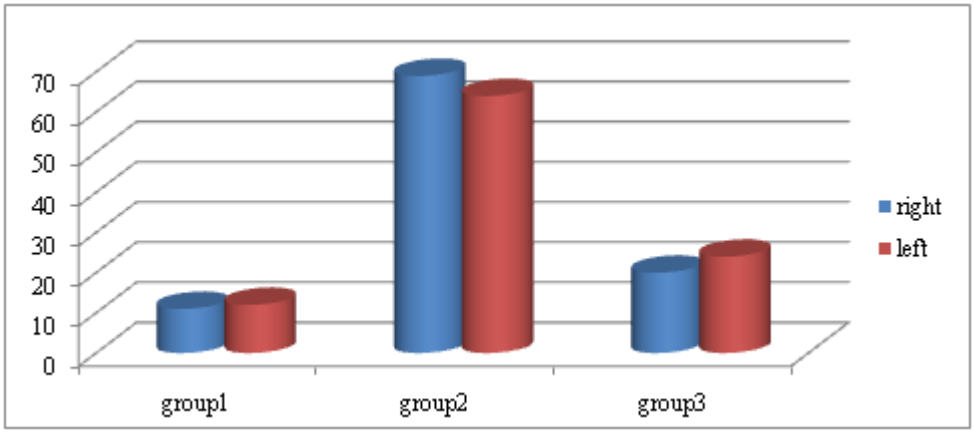
2nd molar disto buccal root	Side				Total	
	Right		Left			
	N	%	N	%	N	%
Group 1	33	22	23	15.3	56	18.7
Group 2	104	69.3	113	75.3	217	72.3
Group 3	13	8.7	14	9.3	27	9
Total	150	100	150	100	300	100



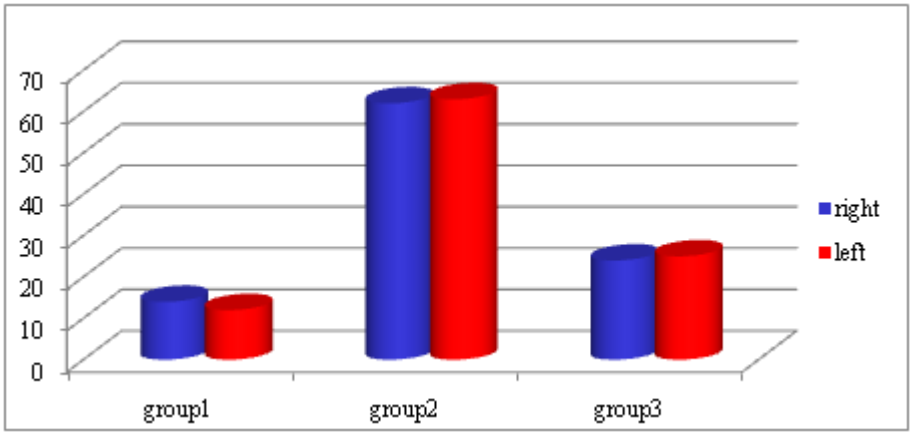
2nd molar palatal	Side				Total	
	Right		Left			
	N	%	N	%	N	%
Group 1	12	8	17	11.3	29	9.7
Group 2	118	78.7	120	80	238	79.3
Group 3	20	13.3	13	8.7	33	11
Total	150	100	150	100	300	100



3rd molar	Side				Total	
	Right		Left			
	N	%	N	%	N	%
Group 1	13	11	15	12	28	11.2
Group 2	84	69	82	64	166	66
Group 3	24	20	31	24	55	22.8
Total	121	100	128	100	249	100



Totally for right side 22% of root tips were included in group 3, 13% in group 1 and 65% in group 2. Where as on the left side 25% of root tip were included in group 3, 12% in group 1 and 63% in group 2.



5. Discussion

Our study documents the anatomical the anatomical relationship between the root tips of maxillary posterior tooth and the maxillary sinus floor. Both right and left sides of each patient were evaluated separately.

The maxillary sinus is the largest of all the paranasal sinuses and, at 10 weeks in utero is the first to develop. After birth, sinus continues to pneumatize into the developing alveolar ridge as the permanent teeth erupt. At 12 to 13 years, the sinus floor is level with the nasal floor, and at age 20, with the completion of the eruption of the third molars, the pneumatization of the sinus ends, and the sinus reaches 5mm inferior to the nasal floor.[1] The inferior sinus wall is a curved structure formed by the lower third of the medial wall and the buccoalveolar wall, and the floor is formed by the alveolar process of the maxilla. The adult sinus is variable in its extension. In about half of the population, the sinus floor extends between adjacent teeth or individual roots, creating elevations in the antral surface, commonly referred to as 'hillocks'. The roots of the maxillary premolar, molar and occasionally canine teeth may project into the maxillary sinus.[4]

Because of the intimate relationship of the maxillary posterior tooth root apices to the maxillary sinus especially in the second molar and the first molar region, it has various implications in treatment planning in the dental field:

There is possibility for the root apices of the posterior tooth to be displaced into the sinus during procedures like extraction, further leading to complications like root apices being displaced into sinus leading to complications like oroantral communications and sinusitis.[5] Hence the clinician must be careful in handling the apical portion of the roots in close proximity to the maxillary sinus floor.

Endodontic surgery of the premolars and molars can result in accidental oroantral communication that can allow bacteria from infected periapical tissues, resected root tips, or bone drilling dust to be displaced into the sinus causing acute or chronic sinusitis. Surgical treatment of posterior tooth is also complicated by redistricted space of the oral

vestibular region, which in turn makes it difficult to raise a flap.[4]

Sinus expansion after extraction can greatly decrease the bone height available for implant placement, [22] hence clinicians conducting prosthetic and pre implant surgical procedures in the posterior maxilla must be aware of the degree of which teeth root protrude into the sinus because of the associated risk of the post extraction pneumatization, which reduces the amount of bone available at the implant or the denture or the denture site.[2] So when ever a dental implant is planned in these cases, the clinicians should consider preserving as much bone height as possible by immediate implantation and or by immediate bone grafting at the time of extraction. These procedures might help maintain the three dimensional architecture of the thin sinus floor in the extraction site until complete healing of the socket takes place thus preventing or decreasing the pneumatization.[1]

Further more the distance between the root apices of the maxillary posterior teeth and the inferior wall of the maxillary sinus has a tendency to influence the orthodontic tooth movement, [3] especially intrusion or bodily movement of the teeth across the sinus floor has been associated with a risk for root resorption and a higher degree of tipping.[2] Orthodontic tooth movement through anatomical limitations such as sinus can be possible. Direction of tooth movement through sinuses could be achieved both postero-anteroir and vertical direction. Light and constant forces is necessary to accomplish these type of tooth movements.[62] Hence the thickness of the inferior wall of the sinus and the relationship with the adjacent teeth is important for determining the prognosis of the orthodontic tooth movement

6. Summary and Conclusion

The results of our study indicate maxillary second and first molar to be in intimate relationship to the maxillary sinus with the distobuccal root of the maxillary second being closest to the maxillary sinus followed by the mesiobuccal root of the second molar. The maxillary first premolar is considered to be farthest away from the sinus followed by the maxillary second premolar.

Knowledge of the anatomical relationship between the maxillary sinus floor and the maxillary posterior teeth root tips is important for the preoperative treatment planning of maxillary posterior teeth. In view of the proximity of the maxillary sinus floor and maxillary root tips, clinicians must be cautious when performing dental procedures involving the maxillary posterior teeth particularly the first and second molars. The measurements found in the present study highlight the need for preoperative treatment planning.

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