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Original Article

Dentistry Section

Association of ABO Blood Groups and Rh Factor with Sagittal and Vertical Skeletal Malocclusion- An Observational Study

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ABSTRACT

Introduction: Various studies have proved the association between several disease including dental crowding, malocclusion and craniofacial deformities with blood group. Certain skeletal problems in sagittal plane are heritable and the skeletal muscle volume and strength, a heritable trait varies with different facial patterns.

Aim: To evaluate the association between ABO blood groups and Rhesus (Rh) factor with skeletal malocclusions in sagittal and vertical plane.

Materials and Methods: An observational study was conducted with a sample of 240 participants who reported to Department of Orthodontics in SRM Dental College and Hospital, Chennai, Tamil Nadu, India seeking orthodontic treatment over a period of two years from September 2018 to December 2020. Participants were assessed for skeletal malocclusion in sagittal and vertical plane and for their ABO and Rh blood grouping. Chi-square test was used for determining the association between sagittal and vertical skeletal malocclusion with ABO and Rh blood grouping. The association of the gender and the malocclusion was determined as a secondary outcome of the study.

Results: A total of 240 participants (mean age: 19.81±5.95 years; 95 males and 145 females) were observed and data was analysed. A significant association was found between Rh positive blood group and skeletal class II malocclusion with high angle (p-value 0.025). Skeletal class I malocclusion with high angle was found to be associated significantly with O^+ group (p-value <0.001). The female gender was found to be associated significantly with sagittal skeletal class II malocclusion with high angle (p-value 0.049).

Conclusion: There is an association between the ABO blood groups and skeletal sagittal malocclusion and vertical skeletal pattern. Skeletal class II malocclusion with high angle pattern was associated significantly with Rh^+ blood group and class I skeletal malocclusion with high angle pattern was significantly associated with O^+ blood group.

Keywords: Heritability of malocclusion, Rhesus factor, Sagittal skeletal malocclusion, Vertical skeletal pattern

INTRODUCTION

In 1901, Karl Landsteiner defined and characterised the ABO antigens that are present in cell membrane of the Red blood cells that determine the blood group [1]. The chromosome 9 bears the genes that code these antigen and is inherited in an autosomal co-dominant fashion [2]. Malocclusions can be acquired or hereditary and the knowledge on the relative contribution of genetics and environmental factors in the aetiology of malocclusion is of paramount importance to an orthodontist [3-5]. Skeletal malocclusion due to prognathic or a retrognathic mandible, facial height and vertical skeletal pattern is strongly influenced by the familial genetic pattern and are heritable [3,6]. A complex relationship exist between the mandibular muscles and underlying vertical facial patterns [7,8]. Difference in muscle structure and strength has been demonstrated between low angle and high mandibular plane angle cases, with brachyfacial types demonstrating a strong muscular environment [7].

Various studies in the past have shown association between prevalence of salivary gland tumours, malaria, cholera, oral cancer, dental caries, haematological malignancies, chicken pox, ischaemic heart disease with certain blood group [9-23]. A recent report on incidence of Coronavirus Disease-2019 (COVID-19) infection among different ABO blood groups showed highest incidence in B group and least with O group [24,25].

Studies have proved the association between different malocclusion including dental crowding, and craniofacial deformities with different ABO blood groups [26,27]. A study conducted by Rathi A et al., showed a highest prevalence of malocclusion in O group and a significant correlation between certain malocclusion and ABO blood groups. Angle's class I malocclusion was found to be more in O blood group, class II in A and class III was most common in B blood group [26]. Another study by Sharma R et al., revealed a strong association between blood groups and malocclusions with prevalence of malocclusions being highest in blood group B, followed by A, O and AB in Jaipur population [28].

A recent study evaluating the association of skeletal malocclusion with blood group in Kerala population showed a strong association of B and O blood group with YEN (developed at Yenepoya Dental College) angle and no association between vertical parameters of malocclusion with any of the blood groups [29]. There is no study in the literature evaluating the association of ABO blood groups and Rh factor with sagittal and vertical skeletal malocclusion in Chennai city population.

Keeping that lacunae in mind, the present study was designed with a null hypothesis, that, there is no association between ABO and Rh blood groups with skeletal malocclusions in sagittal and vertical plane. Hence, the aim was to find any prevalent association.

MATERIALS AND METHODS

An observational study was conducted from September 2018 to December 2020 in the Department of Orthodontics, SRM Dental College and Hospital, Ramapuram, Chennai, Tamil Nadu, India, to evaluate the association of ABO blood groups and Rh factor with sagittal skeletal and vertical skeletal malocclusions. The protocol for the present study was approved by Institutional Review Board and Ethics Committee of SRM university (approval number of SRMDC/IRB/2018/MDS/No.109). The study was registered in The Clinical Trials Registry India (CTRI) with the registration number of CTRI/2020/09/027588.

Informed consent was obtained from the participants about determination of the blood group and utilisation of lateral cephalogram for the present study from the routine records taken for their orthodontic treatment.

Sample size calculation: Sample size was calculated using "N master software" with power 80% and α error 5% the calculated sample size was 240 participants and statistical significance is considered to be at p<0.05 level.

Inclusion criteria: Those patients seeking orthodontic treatment in Department of Orthodontics of the study centre, 15 years to 55 years and who were willing to give written consent to participate in the study were recruited in the study.

Exclusion criteria: Patients affected with craniofacial syndromes, maxillofacial deformities like cleft lip and palate, with history of oral habits such as mouth breathing, digit sucking, tongue thrusting and previous history of orthodontic treatment were excluded from the study.

Study Procedure

Lateral cephalogram of the patients were obtained and manual tracing was performed to assess the sagittal and vertical relationship. ANB angle (2°±2°) and Wits appraisal (2 mm) was used for determining the sagittal skeletal pattern and Go-Gn to SN (31°±3°), FMA - Frankfort Mandibular plane Angle (25°±3°) and Jarabak ratio (62%-65%) was used for determining the vertical skeletal pattern. Class I was considered to be having an ANB angle of 0° to 4°. Class II was considered to be having an ANB angle of greater than 4°. A high vertical angle can be defined as those individuals with Go-Gn to Sn greater than 34°, FMA greater than 28° and Jarabak ratio lesser than 62%. An average vertical angle can be defined as those individuals with Go-Gn to Sn 34°±3, FMA 28°±3 and Jarabak ratio 62% - 65%. A low vertical angle can be defined as those individuals with Go-Gn to Sn lesser than 31°, FMA lesser than 25° and Jarabak ratio greater than 65% [30]. The procedure for blood group determination used includes ABO system and Rhesus system as explained in the study of Sharma R et al., [28].

STATISTICAL ANALYSIS

The association between blood groups and skeletal malocclusions was determined using Chi-square test using Statistical Package for Social Sciences (SPSS) software version 2.0. The p-value <0.05 was considered statistically significant.

RESULTS

The mean age of the participants was 19.81±5.95 years. The distribution of gender, sagittal skeletal relation, blood group and vertical skeletal relation among the sample was calculated [Table/Fig-1]. Males contributed to 95 (39.6%) of the total sample and the distribution of skeletal class I and class II malocclusion was 109 (45.4%) and 131 (54.6%) respectively. When the blood group was analysed based on ABO system, majority of the participants were B^+ 39% followed by O^+ 37.5%. The B^- constituted 3.2% of the sample with AB^+ and AB^- constituting 4.4% and 0.8% respectively. When the blood group was analysed based on the Rh system, Rh^+ constituted 225 (93.75%) and Rh^- constituted 15 (6.25%). High mandibular plane angle was noticed in 94 (39.2%) of the participants, average and horizontal vertical skeletal relation was seen in 78 (32.5%) and 68 (28.3%) of the sample size.

The frequency distribution of sagittal skeletal pattern and vertical skeletal pattern in ABO and Rh blood groups were not statistically significant [Table/Fig-2]. The association of skeletal pattern with ABO blood groupings also showed no statistical significance [Table/Fig-3]. A statistically significant association was found between Rh positive blood group and skeletal class II high angle malocclusion with frequency distribution of 65.9%. When Rh Blood group among various skeletal pattern was analysed with Chi-square test, Rh positive blood group was found to be associated significantly with skeletal class II high angle malocclusion with p-value=0.025 and with Chi-square value of 7.392 [Table/Fig-4,5].

S. No.	Parameters	Groups	Frequency	Percentage (%)
1.	Sagittal skeletal relation [31]	Class I	109	45.4
		Class II	131	54.6
		Total	240	100
2.	Vertical skeletal relation [31]	Average	78	32.5
		High	94	39.2
		Low	68	28.3
		Total	240	100
3.	Gender	Male	95	39.6
		Female	145	60.4
		Total	240	100
4.	Blood groups	A^+	28	11.66
		A^-	3	1.25
		AB^+	11	4.4
		AB^-	2	0.8
		O^+	90	37.5
		O^-	5	2.0
		B^+	94	39.0
		B^-	7	2.9
		Total	240	100

[Table/Fig-1]: Frequency distribution of sagittal skeletal relation, vertical skeletal relation, gender, blood groups among the sample.

Association of skeletal patterns, ABO blood groups and Rh Blood group	Pearson's Chi-square value (χ^2)	df	p-value
Skeletal class I and II in ABO blood group	3.876	3	0.275
Vertical skeletal pattern in ABO blood group	3.884	6	0.692
Skeletal class I and II in Rh blood group	0.010	1	0.920
Vertical skeletal pattern in Rh blood group	1.541	2	0.463

[Table/Fig-2]: Chi-square test for distribution of sagittal and vertical skeletal pattern among different blood groups.
p<0.05 was considered significant

Blood group	Pearson Chi-square (χ^2) value	df	p-value
A	3.431	2	0.180
B	2.842	2	0.242
AB	1.264	2	0.532
O	3.812	2	0.149

[Table/Fig-3]: Chi-square test for frequency distribution of skeletal pattern among different ABO blood groups.
p-value <0.05 was considered significant

Rh blood group	Vertical skeletal pattern		Sagittal skeletal pattern I	Sagittal skeletal pattern II	Total
Positive	Average	Count	39	36	75
		Percentage	52.0%	48.0%	100.0%
	Low angle	Count	33	29	62
		Percentage	53.2%	46.8%	100.0%
	High angle	Count	30	58	88
		Percentage	34.1%	65.9%	100.0%
	Total	Count	102	123	225
		Percentage	45.3%	54.7%	100.0%
Negative	Average	Count	2	1	3
		Percentage	66.7%	33.3%	100.0%
	Low angle	Count	4	2	6
		Percentage	66.7%	33.3%	100.0%
	High angle	Count	1	5	6
		Percentage	16.7%	83.3%	100.0%
	Total	Count	7	8	15
		Percentage	46.7%	53.3%	100.0%

[Table/Fig-4]: Rh blood group, vertical skeletal pattern, sagittal skeletal pattern, cross tabulation.

Rh blood grouping	Pearson's Chi-square (χ^2) value	df	p-value
Positive	7.392	2	**0.025**
Negative	3.616	2	0.164

[Table/Fig-5]: Chi-square tests for: Rh blood group, vertical skeletal pattern, sagittal skeletal pattern, cross tabulation.
p<0.05 was considered significant; bold p-value is significant

A statistically significant association was found between sagittal skeletal class I vertical mandibular pattern and O^+ blood group with frequency distribution of 100%. When blood groups and Rh blood groups among various skeletal patterns were analysed with Chi-square test, sagittal skeletal class I vertical mandibular pattern was found to be associated significantly with blood group O^+ with p-value <0.001 and Chi-square value of 31.00 [Table/Fig-6,7]. A statistically significant association was found between female gender and sagittal skeletal class II high mandibular plane angle with a frequency distribution of 56.3% and when gender distribution among the various skeletal patterns were analysed with Chi-square test, the female gender was found to be associated significantly with sagittal skeletal class II high mandibular plane angle with p-value 0.049 and Chi-square value of 5.751 [Table/Fig-8,9].

Vertical skeletal pattern	Sagittal skeletal pattern	Blood group		Rh		Total
				Positive	Negative	
Average	Sagittal Skeletal class I	A	Count	6	0	6
			Percentage	100.0%	0	100.0%
		B	Count	14	2	16
			Percentage	87.5%	12.5%	100.0%
		AB	Count	2	0	2
			Percentage	100.0%	0	100.0%
		O	Count	17	0	17
			Percentage	100.0%	0	100.0%
		Total	Count	39	2	41
			Percentage	95.1%	4.9%	100.0%
	Sagittal Skeletal class II	A	Count	2	0	2
			Percentage	100.0%	0	100.0%
		B	Count	19	0	19
			Percentage	100.0%	0	100.0%
		AB	Count	1	0	1
			Percentage	100.0%	0	100.0%
		O	Count	14	1	15
			Percentage	93.3%	6.7%	100.0%
		Total	Count	36	1	37
			Percentage	97.3%	2.7%	100.0%
Low angle	Sagittal Skeletal class I	A	Count	6	0	6
			Percentage	100.0%	0	100.0%
		B	Count	9	2	11
			Percentage	81.8%	18.2%	100.0%
		AB	Count	2	1	3
			Percentage	66.7%	33.3%	100.0%
		O	Count	16	1	17
			Percentage	94.1%	5.9%	100.0%
		Total	Count	33	4	37
			Percentage	89.2%	10.8%	100.0%
	Sagittal Skeletal class II	A	Count	4	0	4
			Percentage	100.0%	0	100.0%
		B	Count	13	1	14
			Percentage	92.9%	7.1%	100.0%
		AB	Count	3	0	3
			Percentage	100.0%	0	100.0%
		O	Count	9	1	10
			Percentage	90.0%	10.0%	100.0%
		Total	Count	29	2	31
			Percentage	93.5%	6.5%	100.0%
High angle	Sagittal Skeletal class I	A	Count	5	0	5
			Percentage	100.0%	0	100.0%
		B	Count	12	0	12
			Percentage	100.0%	0	100.0%
		AB	Count	0	1	1
			Percentage	.0%	100.0%	100.0%
		O	Count	13	0	13
			Percentage	100.0%	0	100.0%
		Total	Count	30	1	31
			% Within Blood Group	96.8%	3.2%	100.0%
	Sagittal Skeletal class II	A	Count	7	2	9
			Percentage	77.8%	22.2%	100.0%
		B	Count	28	2	30
			Percentage	93.3%	6.7%	100.0%
		AB	Count	3	0	3
			Percentage	100.0%	0	100.0%
		O	Count	20	1	21
			Percentage	95.2%	4.8%	100.0%
		Total	Count	58	5	63
			Percentage	92.1%	7.9%	100.0%

[Table/Fig-6]: Blood group, Rh, sagittal skeletal pattern, vertical skeletal pattern cross tabulation.

Vertical skeletal pattern	Sagittal skeletal pattern	Pearson's Chi-square (χ^2) value	Df	p-value
Average	Class I	3.285	3	0.350
	Class II	1.507	3	0.681
Low angle	Class I	3.354	3	0.340
	Class II	0.702	3	0.873
High angle	Class I	31.000	3	**<0.001**
	Class II	3.128	3	0.372

[Table/Fig-7]: Chi-square tests for blood group, Rh, sagittal skeletal pattern, vertical skeletal pattern cross tabulation.
p<0.05 was considered significant; bold p-value is significant

Sagittal skeletal pattern	Gender		Vertical skeletal pattern			Total
			Average	Low angle	High angle	
Class I	Male	Count	16	14	14	44
		Percentage	36.4%	31.8%	31.8%	100.0%
	Female	Count	25	23	17	65
		Percentage	38.5%	35.4%	26.2%	100.0%
	Total	Count	41	37	31	109
		Percentage	37.6%	33.9%	28.4%	100.0%
Class II	Male	Count	19	14	18	51
		Percentage	37.3%	27.5%	35.3%	100.0%
	Female	Count	18	17	45	80
		Percentage	22.5%	21.3%	56.3%	100.0%
	Total	Count	37	31	63	131
		Percentage	28.2%	23.7%	48.1%	100.0%

[Table/Fig-8]: Sex, sagittal skeletal pattern, vertical skeletal pattern cross tabulation.

Sagittal skeletal pattern	Pearson's Chi-square (χ^2) value	df	p-value
Class I	0.425	2	0.809
Class II	5.751	2	**0.049**

[Table/Fig-9]: Chi-Square tests for sex, sagittal skeletal pattern, vertical skeletal pattern cross-tabulation.
p<0.05 was considered significant; bold p-value is significant

DISCUSSION

Majority of the participants in the present study, belonged to B^+ blood group and 54.6% comprised of skeletal class II malocclusion, 39.2% comprised of high mandibular plane angle and skeletal class II high angle comprised of 26.25%. Association of skeletal class II high mandibular plane angle malocclusion with Rh^+ blood group was found to statistically significant at p-value <0.05 and association of sagittal skeletal class I vertical mandibular pattern with O^+ blood group was also found to be statistically significant at p<0.001.

[Table/Fig-10] describes about various studies conducted previously regarding association of various oral pathology and blood groups [6,31-35]. Studies in medicine showed significant association of blood groups and various diseases [8,12,15,16,20,21,36]. Though these studies have established the association of blood group with the diseases, the mechanism of such an association is still unclear. Unlike studies in medicine, association of diseases related to oral biology and blood groups are scarce. There is no promising evidence from the literature concerning the association between gender and skeletal malocclusion considered in both sagittal and vertical plane. Komazaki Y et al., discussed on the prevalence of dental malocclusion among gender in a population of Japanese school children under a cross sectional study and concluded that, the girls were 1.56 times more probable to develop malocclusion than boys [33]. Dental malocclusion, despite being governed more by environmental factors, the study did not consider the contribution of habits, duration of infantile feeding, genetic factors towards such a probability of increased incidence of dental malocclusion in female gender [35]. In the present study, the association of female gender among skeletal class II vertical malocclusion was significant, which can be due to increased incidence of female reported in the study.

The studies by Schnibben CL [34], Flannery PM [35] considered the malocclusions in sagittal plane only. Schnibben CL concluded that class II malocclusion was associated significantly with blood group A and Flannery PM concluded that, class III malocclusion showed no significant association with any blood group. Both these studies did not mention about the association of gender, Rh blood grouping, vertical skeletal pattern and its subgroups with malocclusion [34,35]. The results of this study showed significant association of Rh^+ blood group with skeletal class II high mandibular plane angle malocclusion but when the malocclusions were considered separately, Rh^+ blood group showed insignificant association with skeletal class II or class I malocclusion or vertical skeletal pattern malocclusion. The results of the present study further showed that the association of skeletal class I vertical malocclusion was significant with the blood group O^+.

Significant association between Rh^+ blood group and skeletal class II vertical skeletal pattern malocclusion was found in this study. Thus, rejecting the null hypothesis considered for the present study. The possibility of such an association of Rh^+ blood group with skeletal class II high mandibular plane angle malocclusion may be suggestive that the gene(s) controlling the Rh^+ blood group might also control the phenotype skeletal class II high mandibular plane angle malocclusion. The possibility of such an association might also be due to increased incidence of Rh^+ blood group in the recruited population. Hence, future studies with still larger population could reveal more specific associations between such phenotypes which would be of immense benefit for the scientific community pursuing the genetic research.

S. No.	Author's name and year	Place of study	Number of subjects	Age considered	Parameters compared	Conclusion
1.	Gheisari R et al., [6]	Isfahan	190	No age restriction	Blood group and maxillofacial deformity	Less prevalent in blood type A and more in blood type B
2.	Vivek S et al., [31]	Virajpet	220	No age restriction	periodontal diseases and ABO blood groups.	Periodontal diseases is more with blood type O^+
3.	Demir T et al., [32]	Turkey	10	No age restriction	Amount of CFU in periodontal pockets among various blood groups	No statistical significance
4.	Komazaki Y et al., [33]	Japan	821	12-15 years	Gender and dental malocclusion	Girls with more dental malocclusion than boys.
5.	Schnibben CL [34]	Chicago	50	No age restriction	Class II division 1 dental malocclusion and blood group	Class II dental malocclusion more in blood group A
6.	Flannery PM [35]	Chicago	50	No age restriction	Class III dental malocclusion and blood group	No statistical significance
7.	Present study	India	240	No age restrictions	Blood group, Rhesus blood group, sagittal and vertical skeletal malocclusion, Gender	Association of class II high angle with Rh^+ blood group, class I high angle with O^+ blood group

[Table/Fig-10]: Comparative analysis of previous studies results with present study [6, 31-35].

Limitation(s)

The results of the present study should be interpreted with caution as the representative sample showed a large incidence of Rh^+ blood group. More specific association could be revealed by increasing the sample size of different ethnic origins.

CONCLUSION(S)

There is an association between the ABO blood groups and skeletal sagittal malocclusion and vertical skeletal pattern. Skeletal class II malocclusion with high angle pattern was associated significantly with Rh^+ blood group and class I skeletal malocclusion with high angle pattern was significantly associated with O^+ blood group. Future genetic studies in the direction of determining the common gene for the expression of multiple phenotype would be beneficial and studies evaluating the association of blood group and oral habits in causing the malocclusion would help in determining the heritability of oral habits, if any.

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