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Research Article

Association of Dentoskeletal Malocclusions with ABO Blood Groups: A Cross-Sectional Study

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Abstract

Background: Malocclusion has a multifactorial aetiology and can be attributed to local as well as general factors. Genetics plays a significant role in aetiology of malocclusion. Malocclusion is considered as a quantitative genetic trait with continuous graded distribution in the population. Association between various oral diseases with ABO blood groups have been established in the past. ABO blood groups are one of the most important human genetic traits that follows Mendalian inheritance. Since both the ABO blood groups and malocclusion are genetic traits, authors have carried out studies to assess if association between the two exists. Cross sectional study was carried out is to assess the association between dental, skeletal malocclusions with the ABO blood groups.

Materials and Methods: This was a cross-sectional observational study conducted in 100 subjects in the range of 18-28 years. Standard pretreatment study models and lateral cephalograms were taken. Dental malocclusion was assessed from study models. Cephalograms were analyzed for three vertical skeletal cephalometric parameters which included FMA angle, Y -axis, Sn-GoGn Angle. Five sagittal cephalometric parameters which included ANB angle, WITS appraisal, App-Bpp, YEN angle and Beta angle. Blood group assessment was done using the point of care device Erycard2.0. Statistical analysis was done using IBM SPSS version 23 and p value ≤ 0.5.

Results: This study concluded that there was no statistically significant association between dentoskeletal malocclusions and ABO blood groups. Also, there is lack of data regarding any association between the genotypes of dental and skeletal malocclusions with alleles of ABO blood groups.

Keywords: Skeletal Malocclusion; Dental Malocclusion; ABO Blood Groups

Introduction

Malocclusion is defined as an appreciable deviation from ideal occlusion that may be considered aesthetically or functionally unsatisfactory [1]. It has spectrum of deviations from abnormal tooth positions intra-arch or inter-arch to mal-positioning between jaw bases [2].

Malocclusion has a multifactorial origin and cannot be attributed to a single cause [3]. Twin and familial studies have provided strong evidence regarding heritability pattern of malocclusion [3,4]. However, due to the multifactorial characteristic of craniofacial development, it is difficult to identify a specific genetic pattern for a particular type of malocclusion [5].

Several epidemiological studies have been conducted to associate malocclusions with other genetic characteristics in order to recognize the genetic patterns of various dentoskeletal malocclusions [5-7]. One such genetic characteristic is ABO blood group, which is a qualitative genetic trait and can be estimated by Mendelian genetics [3]. The objective of the study was to evaluate the association of dental as well as skeletal malocclusions with ABO blood groups In

the past, studies have largely focused on finding association between dental malocclusions and ABO blood groups [8-13]. Fewer studies have focused on finding association between skeletal component of malocclusion with ABO blood groups which is shown to have greater component of heritability [14-17]. If such association exists, we can use results and apply it to infer future growth patterns and developing dental malocclusions in children with specific blood groups.

Aims and Objectives

Aim of the study was to investigate association dental and skeletal malocclusion with ABO blood groups.

Objectives

- To assess the association of the sagittal skeletal malocclusions as seen on the lateral cephalogram with ABO blood groups.
- To assess the association of vertical skeletal parameters as seen on the lateral cephalogram with ABO blood groups.
- To assess the association of Dental malocclusions with ABO blood groups.
- To determine the distribution of types of dentoskeletal malocclusions with respect to ABO blood groups.

Materials and Methods

This was a cross-sectional observational study conducted in 100 subjects in the range of 18-28 years. Standard pre-treatment records including study models and lateral cephalograms were taken. The ethical committee meeting decided to keep equitable number of subjects of each blood group in the study, so 25 subjects each of A, B, AB, and O blood groups were selected.

- **Assessment of study models:** The study models were assessed to determine Angles malocclusion and divided into Angle's Class I, Class II and Class III.
- **Assessment of lateral cephalogram:** Cephalometric analysis was performed to ascertain the sagittal and vertical skeletal parameters. Five sagittal skeletal parameters and three vertical parameters were assessed. Sagittal parameters included were ANB, YEN angle, Wits appraisal, App-Bpp and Beta angle. Vertical parameters included were FMA, Sn-GoGn and Y- axis. Minimum of two vertical cephalometric parameters and minimum of three sagittal cephalometric parameters were used to make the final inference in the respective categories.
- **ANB angle:** It is the angle between SNA and SNB consist of A point, Nasion, B point and indicates whether the skeletal relationship between the maxilla and mandible is a normal skeletal class I (2° -4°), a skeletal Class II (+4° or more), or skeletal class III (0°or negative) relationship [20].
- **Beta angle:** The angle between the A-B line and the perpendicular through point A from the apparent axis of the condyle (C) constitutes the beta angle. Beta angle between 27° - 35° can be considered to have class I skeletal pattern. Value less than 27° is considered as skeletal Class II and greater than 35° as skeletal Class III [20,21].
- **Yen angle:** It is formed by the intersection of S (Sella), M (midpoint of the anterior maxilla), and G (center at the bottom of the symphysis), to form the YEN angle measured at M (117°- 123°). Value less than 117° is considered as skeletal Class II pattern and greater than 123° is considered skeletal Class III pattern [20,21].
- **Wits appraisal:** Perpendicular is drawn from Point A and Point B to functional occlusal plane. The distance between perpendicular projection is 0 mm in females with Class I and in males BO is 1mm ahead of AO.BO more behind of AO in Class II and BO more forward of AO in Class III pattern [20,21].
- **App-Bpp:** It measures perpendicular distance from Point A and Point B to palatal plane. It measures 5.2±2.9 mm in females and 4.8± 3.6 mm in males. It increased in Class II and decreased in Class III [20,21].

Parameters used for assessment of vertical facial pattern are following

- **Sn-GoGn:** According to Steiner, Sn- GoGn is formed by the intersection of mandibular plane (Go-Gn) and Sella (S) and Nasion (N). Larger angle indicate a vertical facial pattern, smaller angle indicates horizontal facial pattern, the mean angle is 32° in average facial pattern [22].

- **FMA:** It is the angle formed between the Frankfort horizontal plane (FH) and the mandibular plane. FMA of 25° is within normal range. A high angle patient has an FMA of 27° or more, and a low angle patient has FMA of 23° or less [22].
- **Y- Axis:** Down's analysis uses Y- axis to assess the vertical skeletal discrepancies. This angle is formed at the intersection of Sella-Gnathion line with the Frankfort Horizontal Plane. Larger angles 28 indicate vertical facial patterns, and smaller angles (less than 61°) indicate horizontal facial patterns, the mean angle is 59.4° in average facial patterns [22].

ABO Blood group assessment

It was done using the point of care device called Erycard2.0 [23,24]. This rapid agglutination card with four wells precoated with A, B and Rh antibodies in dry state and an auto-control group. Blood samples are collected on collection loop sticks added to each of the four wells ensuring that only the blood drop was in contact with the reagent of the well. After two minutes, two drops of reagent buffer were 29 added to each well.

After waiting for three minutes, the results were interpreted. Wells in which agglutination reaction took place stayed red and rest become colorless. The wells with red patch indicated the blood group of the patient. The auto control should always show a colorless patch for valid interpretation. The result of the patient was noted.

Interpretation of results

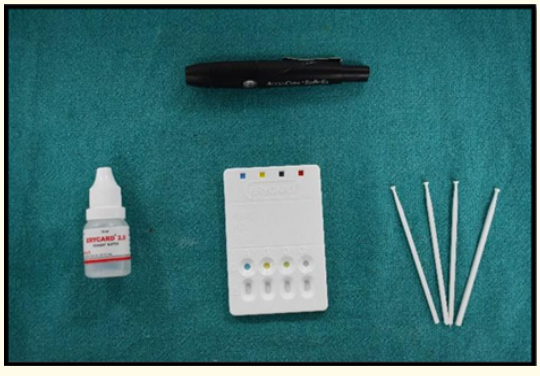

Figure 1: Erycard 2.0 kit containing Erycard, reagent buffer, loop sticks with Accu check lancet device.

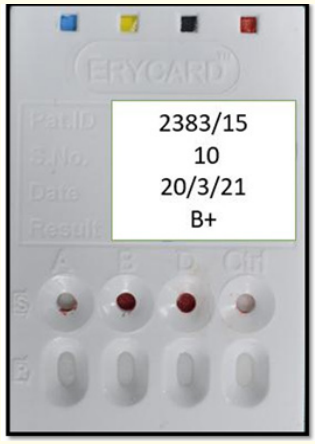

Figure 2: Erycard 2.0 with results written on the card.

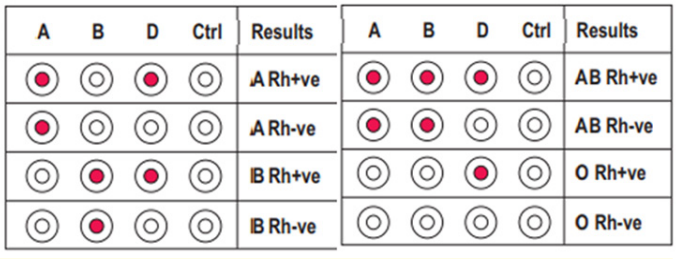

Figure 3: Interpretation of Results.

Statistical analysis

Statistical analysis was done using IBM SPSS version 23 and p value < 0.05 was considered as statistically significant. The study consisted of continues variables and categorical variables. Continues variables included three vertical skeletal cephalometric parameters and five sagittal cephalometric parameters and categorical variables included blood groups, Angle's malocclusion, sagittal and vertical inferences. Normality of the data was evaluated using Shapiro-Wilks test. Group comparisons for continuously distributed data were made using One-Way ANOVA test. If data were found to be non-normally distributed, appropriate non-parametric tests in the form of Kruskal Wallis Test were used. Chi-square test was used for group comparisons for categorical data.

Inclusion criteria

All permanent teeth present in each arch and in sufficient state of eruption.

Exclusion criteria

- History of trauma to the temporomandibular joint,
- History of previous orthodontic treatment,
- History of pathology or any other systemic disease/condition or syndrome affecting jaw growth,
- History of systemic diseases, for example, autoimmune diseases.

Results

- The results of study reported no significant difference between the various ABO blood groups in terms of distribution of Sagittal Inference ($\chi 2 = 9.776$, $p = 0.134$). There was no significant difference between the various ABO blood groups in terms of distribution of Vertical Inference ($\chi 2 = 3.068$, $p = 0.800$).

Parameters	ABO Blood Group				p value
	A (n = 25)	B (n = 25)	AB (n = 25)	O (n = 25)	
Sagittal ANB	3.56 ± 3.52	5.06 ± 3.72	3.36 ± 2.25	4.36 ± 4.42	0.288[1]
Sagittal Wits	2.48 ± 3.61	2.84 ± 3.30	1.92 ± 2.74	2.88 ± 3.93	0.403[1]
Sagittal APP BPP	5.28 ± 4.47	6.54 ± 4.73	5.00 ± 3.43	6.80 ± 4.19	0.236[1]
Sagittal Beta Angle	29.00 ± 5.68	27.96 ± 6.65	29.00 ± 5.77	26.32 ± 5.70	0.342[3]
Sagittal Yen Angle	122.48 ± 7.14	120.96 ± 7.31	122.48 ± 4.68	119.48 ± 6.06	0.310[1]
Sagittal Inference					0.134[2]
Class I	4	9	10	5	
Class II	13	13	9	17	
Class III	8	3	6	3	
Vertical FMA	24.08 ± 6.06	27.24 ± 6.19	23.56 ± 5.35	24.60 ± 6.10	0.135[3]
Vertical Yaxis	60.64 ± 3.98	62.04 ± 4.81	60.08 ± 3.89	62.00 ± 4.34	0.269[3]
Vertical Sn-GoGn	28.88 ± 5.79	30.44 ± 4.98	28.60 ± 5.50	30.36 ± 5.84	0.603[1]
Vertical Inference					0.800[2]
Horizontal	11	7	12	9	
Average	7	8	7	9	
Vertical	7	10	6	7	
Angle Malocclusion					0.272[4]
Class I	15	15	15	10	
Class II	9	10	7	14	
Class III	1	0	3	1	

Table 1: Association between ABO Blood Group and Parameters.

***Significant at $p < 0.05$, 1: Kruskal Wallis Test, 2: Chi-Squared Test, 3: One-Way ANOVA, 4: Fisher's Exact Test.

Sagittal Inference				
Class I	4 (16.0%)	9 (36.0%)	10 (40.0%)	5 (20.0%)
Class II	13 (52.0%)	13 (52.0%)	9 (36.0%)	17 (68.0%)
Class III	8 (32.0%)	3 (12.0%)	6 (24.0%)	3 (12.0%)
Vertical Inference				
Horizontal	11 (44.0%)	7 (28.0%)	12 (48.0%)	9 (36.0%)
Average	7 (28.0%)	8 (32.0%)	7 (28.0%)	9 (36.0%)
Vertical	7 (28.0%)	10 (40.0%)	6 (24.0%)	7 (28.0%)
Angle Malocclusion				
Class I	15 (60.0%)	15 (60.0%)	15 (60.0%)	10 (40.0%)
Class II	9 (36.0%)	10 (40.0%)	7 (28.0%)	14 (56.0%)
Class III	1 (4.0%)	0 (0.0%)	3 (12.0%)	1 (4.0%)

Table 2: Distribution of different parameters in ABO BLOOD GROUPS.

- There was no significant difference between the various ABO blood groups in terms of distribution of Angle Malocclusion ($\chi 2 = 7.764$, $p = 0.272$).
- **Distribution of ABO blood groups in dental malocclusion:** Angle's Class I malocclusion was highest in A blood group and least in O blood group Angle's Class II malocclusion it was highest in blood group O and least in AB blood group and Angle's Class III malocclusion was highest in AB blood group and least in B blood group.
- **Distribution of ABO blood groups in sagittal skeletal malocclusion:** Skeletal Class I distribution was highest in AB blood group and lowest on O blood group. Skeletal Class II distribution was highest in O blood group and lowest AB blood group. Whereas skeletal Class III was highest in A blood group and lowest in A and B blood groups.
- **Distribution of Vertical skeletal pattern:** Average skeletal pattern was maximum in O blood group and minimum in A and AB blood groups. Horizontal growth pattern was maximum in A blood group and minimum in AB and O blood groups. Vertical skeletal pattern was maximum in B blood group and minimum in AB blood groups.

Discussion

Malocclusion is a continuous multifactorial trait which is determined by combination of polygenes and environmental factors [3,4]. Due to the multifactorial characteristic of craniofacial development, it is difficult to identify a specific genetic pattern for a particular type of malocclusion [7]. Studies have been conducted to correlate or associate the malocclusion with other genetic characteristics in order to recognize the genetic patterns of various dentoskeletal malocclusions. One such genetic characteristic is ABO blood group which is a qualitative genetic trait. ABO blood groups are important for purpose of blood transfusions but literature has revealed significant relationship of ABO blood groups with numerous diseases. Studies have reported significant association of ABO blood groups with diseases like gastric ulcers, ischemic heart diseases and several other chronic diseases [23,24]. Similarly, statistically significant associations were reported between oral diseases and ABO blood groups. Vivek S., *et al*, Koregol AC., *et al.* found greater propensity of periodontitis and gingivitis in patients with O blood group respectively [25,26]. Based on these findings other researchers then evaluated the relationship malocclusions and ABO blood groups.

Association of ABO blood groups with dental malocclusion

The results showed no statistical significance difference between the ABO blood groups in terms of distribution of Angle's Malocclusion. Hence it was concluded that no significant association exists between Angle's malocclusion and ABO blood groups. These results were similar to the findings of Shokor FF., *et al,* Gupta SP and Al- Khatieeb MM., *et al.* [11-13]. On the other hand, authors like Sharma R., *et al*, Gupta P., *et al.* and Rashid A., *et al*. reported statistically significant association between ABO blood groups and Angle's malocclusion [8-10]. Evidence from literature has established that the dentoalveolar traits of malocclusion have lower heritability because of a stronger environmental influence than hereditary and dental malocclusions are affected by local environmental factors like retained deciduous teeth, supernumerary teeth, crowding and neighbouring soft tissues [4].

Association of ABO blood groups with vertical facial pattern

Present study investigated association between ABO blood groups and vertical facial pattern in the participating subjects. FMA, Y-AXIS, Sn-GoGn angle were the three vertical skeletal cephalometric parameters used to evaluate the vertical facial patterns. Findings revealed no significant association between any of the vertical skeletal parameters and ABO blood groups. These findings were in accordance with findings of John G., *et al.* [19].

Association of ABO blood groups with sagittal malocclusion

In this study, we evaluated association between five sagittal cephalometric parameters and ABO blood groups and reported that there is no association between sagittal malocclusion and ABO blood groups. This was in agreement to several studies in the past [12,15,18].

However, John G found significant association between YEN angle and ABO blood groups [17]. Scnibben CL also found significant association between A blood group and skeletal class II malocclusion using ANB as a cephalometric parameter [19].

The contrasting results of different studies can be attributed to racial/ethnic variations and geographic differences in distribution of blood groups as well as malocclusion [8-10]. Large variation in prevalence of malocclusion among different geographic regions/

ethnicities and variation in distribution of ABO blood groups in different ethnicities and populations are the main factors for the contrary results in different studies [28].

This study concluded that there was no statistically significant association between dentoskeletal malocclusions and ABO blood groups. Also, there is lack of data regarding any correlation/association between the genotypes of dental and skeletal malocclusions with alleles of ABO blood groups. Hence in future studies, we can use molecular analysis to evaluate any association between genetic pathways of dental malocclusions, sagittal malocclusions, and vertical facial patterns with alleles of the ABO blood group.

Future Scope

As discussed earlier, malocclusions are determined by combination of genetic and environmental factors. Studies in the literature have found significant association between various genetic pathways and sagittal malocclusion and vertical facial patterns. Genes like ACTN3 and MYO1H are reportedly associated with vertical skeletal pattern [29]. Also, association of ABCA4-ARHGAP 29 locus have been associated with vertical facial phenotypes like skeletal open bites and deep bites [31]. Sagittal Class II and Class III malocclusions have also been associated with SNPs of genes like COL1A1, FGFR2, MYO1H [31]. Certain genes like KAT6B and HDAC4 are found to be expressed more in skeletal class III whereas deficiency of RUNX2 is associated with Skeletal Class II [30].

Various studies have reported statistically significant association between dentoskeletal malocclusions and ABO blood groups but there is lack of data regarding any correlation/association between the genotypes of the dental and skeletal malocclusions with alleles of ABO blood groups. Hence in future studies, the focus can be shifted to performing molecular analysis in order to assess association between SNPs of dental malocclusions, sagittal malocclusions and vertical facial patterns with ABO blood group alleles. One investigation can be between factors like RUNX2 of skeletal Class II with RUNX1 of ABO blood groups.

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