



Association between Abo Blood Groups and Periodontal Disease Severity: A Cross-Sectional Study

*Dr. Dharshana Baskar¹, Dr. Praveen B Kudva², Dr.V. Balaji³, Dr. Hema Puranik AR⁴

¹Post graduate, Department of Periodontology and Implantology, Sri Siddhartha Dental College and Hospital, SSAHE, Tumkur, India

²Professor and Dean, Department of Periodontology and Implantology, Sri Siddhartha Dental College and Hospital, SSAHE, Tumkur, India

³Post graduate, Department of Periodontology and Implantology, Sri Siddhartha Dental College and Hospital, SSAHE, Tumkur, India

⁴Associate Professor, Department of Anatomy, Sri Siddhartha Medical College, SSAHE, Tumkur, India

*Corresponding Author: Dr. Dharshana.B

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ABSTRACT:

Introduction: Periodontal diseases represent a spectrum of inflammatory conditions affecting tooth-supporting structures, with multifactorial etiology involving microbial, genetic, environmental, and host factors. The ABO blood group system consists of genetically determined antigens present on red blood cell membranes and various tissues, potentially influencing disease susceptibility through immunological mechanisms. Despite significant advances in understanding periodontal pathogenesis, the role of genetic predisposition, particularly blood group antigens, remains an area of active investigation with conflicting research findings.

Objectives: To investigate the association between ABO blood group phenotypes and periodontal disease severity in a South Indian population, and to establish any significant correlations between blood group distribution and clinical periodontal parameters.

Methods: A cross-sectional observational study was conducted among 647 systemically healthy individuals aged 18-60 years attending the Department of Periodontics. Participants were categorized based on ABO blood groups and Rh factor using standard agglutination techniques. Periodontal status was comprehensively assessed using Plaque Index, Gingival Index, Probing Pocket Depth, and Clinical Attachment Level at six sites per tooth. Participants were classified into three groups: mild gingivitis, moderate gingivitis, and periodontitis. Statistical analysis was performed using chi-square tests and ANOVA with significance set at $p < 0.05$.

Results: Blood group O was most prevalent (57.7%), followed by B (23.1%), A (13.8%), and AB (2.3%). Rh-positive individuals constituted 96.9% of the sample. Moderate gingivitis was observed in 35.4% participants, mild gingivitis in 40.0%, and periodontitis in 24.6%. Blood group A showed higher prevalence in gingivitis groups (35.9% mild, 34.8% moderate), while blood group O demonstrated increased association with periodontitis (23.6%). Mean periodontal parameters showed no significant differences across blood groups. Chi-square analysis revealed no statistically significant association between ABO blood groups and periodontal disease severity ($\chi^2=7.342$, $p=0.290$). Age was significantly associated with periodontal status ($p < 0.001$), while gender and Rh factor showed no association.

Conclusions: This large-scale study found no statistically significant association between ABO blood group phenotypes and periodontal disease severity in a South Indian population. While observational trends suggested blood group A individuals might have higher gingivitis prevalence and blood group O individuals showing increased periodontitis occurrence, these observations did not reach statistical significance. The findings suggest that ABO blood group phenotypes may not serve as reliable predictors of periodontal disease susceptibility in isolation.



1. Introduction

Periodontal diseases represent a spectrum of inflammatory conditions affecting the supporting structures of teeth, including the gingiva, periodontal ligament, cementum, and alveolar bone [1,2,3]. These conditions range from reversible gingivitis to severe periodontitis, characterized by progressive destruction of tooth-supporting tissues and eventual tooth loss if left untreated. The etiology of periodontal diseases is multifactorial, involving complex interactions between microbial, genetic, environmental, and host factors [1,14,15].

Despite significant advances in understanding periodontal pathogenesis over the past several decades, the role of genetic predisposition, particularly blood group antigens, remains an area of active investigation [4,5,6]. The recognition that individuals respond differently to similar levels of bacterial challenge has led researchers to explore various host factors that may influence disease susceptibility and progression.

The ABO blood group system, first described by Karl Landsteiner in the early 1900s, represents one of the most important genetic polymorphisms in humans [7,8]. This system consists of genetically determined antigens present not only on red blood cell membranes but also on various tissues throughout the body, including epithelial surfaces. The fundamental biological importance of these antigens extends beyond their role in blood transfusion medicine, as they have been associated with susceptibility to various systemic diseases [9,10,17].

The association between ABO blood groups and systemic diseases has been well documented in medical literature. Epidemiological studies have demonstrated relationships between blood group O and increased risk of coronary heart disease, while blood groups A and O have been linked to diabetes mellitus [9,27]. These associations suggest that blood group antigens may play functional roles in disease pathogenesis, possibly through effects on inflammation, thrombosis, or microbial adhesion [10,17].

Given the limited and conflicting evidence regarding ABO blood group associations with periodontal diseases, particularly in Indian populations where such studies are relatively scarce, this research was undertaken. India represents a genetically diverse population with unique blood group distribution patterns and high periodontal disease prevalence [19,20,28]. Understanding the potential

relationship between ABO blood groups and periodontal disease in this population could contribute to better risk assessment and personalized treatment approaches.

This study aimed to investigate the prevalence of periodontal disease among different ABO blood groups in a large cohort from South India and to establish any significant correlations between blood group phenotypes and periodontal disease severity. Additionally, the study sought to examine the distribution of ABO blood groups and Rh factor in the study population and to assess whether these genetic markers could serve as useful predictors of periodontal disease susceptibility.

2. Objectives

The primary objective of this study was to investigate the association between ABO blood group phenotypes and periodontal disease severity in a South Indian population. Specifically, the study aimed to determine whether individuals with different blood groups exhibited varying susceptibility to periodontal diseases.

Secondary objectives included determining the prevalence and distribution of ABO blood groups and Rh factor among study participants attending a tertiary dental care center in South India. The study also sought to assess the distribution of periodontal disease conditions (mild gingivitis, moderate gingivitis, and periodontitis) across different blood group phenotypes.

Furthermore, the research aimed to compare clinical periodontal parameters, including Plaque Index, Gingival Index, Probing Pocket Depth, and Clinical Attachment Level, among individuals with different ABO blood groups. An additional objective was to evaluate the association between Rh factor and periodontal disease severity.

The study also aimed to examine potential confounding factors, including age and gender, in the relationship between blood groups and periodontal status. Finally, based on the findings, the research sought to determine whether ABO blood group phenotypes could serve as useful predictive markers for periodontal disease susceptibility in clinical practice.

3. Methods

Study Design and Setting

This cross-sectional observational study was conducted at the Department of Periodontics, Sri Siddhartha Dental College and Hospital, Tumkur, Karnataka, India. The



study was conducted over a period of 12 months from January 2023 to December 2023. This institution serves as a tertiary dental care center, providing comprehensive dental services to patients from Tumkur and surrounding districts.

Ethical Approval and Informed Consent

The study protocol was submitted to and approved by the Institutional Ethics Committee of Sri Siddhartha Dental College and Hospital (IEC approval number: IEC/SSDC/2023/001). The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki for medical research involving human subjects.

All eligible participants were provided with detailed information about the study objectives, procedures, potential risks, and benefits. Written informed consent was obtained from all participants before enrollment in the study. Participants were informed of their right to withdraw from the study at any time without any consequences to their dental care. Confidentiality of participant data was maintained throughout the study by using unique identification codes and storing all personal information in password-protected digital files.

Sample Size Calculation

Sample size calculation was performed using G*Power statistical software version 3.0.1 (Franz Faul Universität, Kiel, Germany). The calculation was based on chi-square goodness-of-fit tests for contingency tables, which is appropriate for assessing associations between categorical variables such as blood groups and periodontal disease categories.

The following parameters were used for sample size calculation: effect size (w) of 0.2 (representing a small to medium effect), alpha error probability of 0.05 (corresponding to 95% confidence level), statistical power ($1-\beta$) of 0.95 (providing 95% power to detect significant differences), and degrees of freedom of 12 (based on the cross-tabulation of 4 ABO blood groups and 3 periodontal disease categories).

Based on these parameters, the calculated required sample size was 647 participants. This sample size provides adequate statistical power (95%) to detect significant differences at the 0.05 significance level, ensuring robust statistical analysis and reliable conclusions.

Participant Selection and Sampling

A total of 647 systemically healthy individuals aged 18-60 years were recruited for this study. Participants were selected from patients attending the Out-Patient Department of Periodontics at Sri Siddhartha Dental College and Hospital for various dental complaints or routine dental check-ups.

A systematic random sampling technique was employed for participant selection. Every third patient meeting the eligibility criteria and providing informed consent was included in the study until the required sample size was achieved. This sampling method ensured representation across different age groups, genders, and socioeconomic backgrounds while maintaining randomization.

Inclusion Criteria

The inclusion criteria for study participation were: individuals aged between 18 and 60 years of either gender; systemically healthy individuals without any major medical conditions; participants who had not received any periodontal treatment (including scaling, root planing, or periodontal surgery) within the past 12 months; individuals with at least 20 natural teeth present in the oral cavity; and participants willing to provide written informed consent for participation in the study.

Exclusion Criteria

The exclusion criteria included: pregnant women or lactating mothers, as hormonal changes during pregnancy and lactation can affect periodontal status; current smokers or individuals with a history of smoking within the past 5 years, as smoking is a well-established risk factor for periodontal disease; individuals with chronic alcohol consumption habits; patients currently taking antibiotics, analgesics, or anti-inflammatory medications for any medical or dental reasons; individuals on long-term medication for chronic systemic diseases; patients with systemic diseases known to affect periodontal status, including diabetes mellitus, cardiovascular diseases, immunological disorders, or blood dyscrasias; individuals with a history of orthodontic treatment within the past 6 months; and patients who had undergone dental extractions within the past 3 months.

Clinical Examination Procedures

All clinical examinations were performed by a single calibrated examiner who was a postgraduate student in



the Department of Periodontics. Prior to the commencement of the study, the examiner underwent calibration training to ensure reliability and consistency in periodontal parameter recording. Intra-examiner reliability was assessed using Cohen's Kappa coefficient, which was found to be 0.87, indicating substantial agreement and acceptable reliability.

Participants were examined in a dental chair under adequate artificial illumination using a standard dental examination light. Standard infection control protocols were followed, including the use of personal protective equipment (gloves, masks, and protective eyewear) and sterilization of all instruments between patients.

The following periodontal parameters were systematically recorded at six sites per tooth (mesio-buccal, mid-buccal, disto-buccal, mesio-lingual, mid-lingual, and disto-lingual) for all teeth present, excluding third molars. A Williams periodontal probe with millimeter markings was used for all measurements.

Plaque Index (PI): The Plaque Index developed by Silness and Løe (1964) was used to assess the quantity of dental plaque. Scores range from 0 to 3: 0 = no plaque; 1 = a film of plaque adhering to the free gingival margin and adjacent area of the tooth, visible only after application of disclosing solution or by running a probe across the tooth surface; 2 = moderate accumulation of soft deposits within the gingival pocket, or on the tooth and gingival margin, which can be seen with the naked eye; 3 = abundance of soft matter within the gingival pocket and/or on the tooth and gingival margin.

Gingival Index (GI): The Gingival Index described by Løe and Silness (1963) was employed to assess gingival inflammation. Scores range from 0 to 3: 0 = normal gingiva; 1 = mild inflammation, slight change in color, slight edema, no bleeding on probing; 2 = moderate inflammation, redness, edema and glazing, bleeding on probing; 3 = severe inflammation, marked redness and edema, ulceration, tendency to spontaneous bleeding.

Probing Pocket Depth (PPD): Probing pocket depth was measured as the distance from the gingival margin to the base of the periodontal pocket. The periodontal probe was inserted parallel to the long axis of the tooth with gentle pressure (approximately 25 grams) until resistance was felt. Measurements were recorded to the nearest millimeter.

Clinical Attachment Level (CAL): Clinical attachment level was measured as the distance from the cemento-

enamel junction to the base of the periodontal pocket. When the cemento-enamel junction was covered by gingival tissue, the distance from the gingival margin to the cemento-enamel junction was first determined, and this measurement was either added to or subtracted from the pocket depth measurement to calculate the clinical attachment level.

All measurements were recorded on a standardized periodontal examination form, and data were subsequently entered into a computerized database for statistical analysis.

Blood Group Determination

ABO blood grouping and Rh typing were performed for all study participants using the standard tube agglutination technique, which is considered the gold standard for blood group determination. Blood samples (2-3 ml) were collected by venipuncture under aseptic conditions by a trained phlebotomist.

The forward grouping (cell grouping) was performed by mixing the patient's red blood cells with commercially available anti-A, anti-B, and anti-D sera on a clean glass slide. The reverse grouping (serum grouping) was performed to confirm the results by testing the patient's serum against known A and B cells. Blood group was determined based on the pattern of agglutination observed.

Quality control was maintained by using fresh reagents, performing both forward and reverse grouping for all samples, and ensuring proper storage of reagents as per manufacturer's instructions. All blood grouping procedures were performed in the hospital's clinical laboratory by experienced laboratory technicians who were blinded to the participants' periodontal status.

Periodontal Disease Classification

Based on the clinical examination findings, participants were classified into three groups according to their periodontal status:

Group I (Mild Gingivitis): Participants with Gingival Index scores ranging from 1 to 2, presence of gingival inflammation without clinical attachment loss (CAL = 0), and no radiographic evidence of bone loss.

Group II (Moderate Gingivitis): Participants with Gingival Index scores ranging from 2 to 3, more severe gingival inflammation with bleeding on probing, no



clinical attachment loss (CAL = 0), and no radiographic evidence of bone loss.

Group III (Periodontitis): Participants with clinical attachment level (CAL) of 3 mm or more at two or more sites, presence of periodontal pockets, and radiographic evidence of alveolar bone loss. This group included both moderate and severe periodontitis cases according to the current periodontal disease classification.

Data Collection and Management

All study data were collected using standardized case report forms that included sections for demographic information, medical history, blood group determination results, and detailed periodontal examination findings. Data quality was ensured through regular supervision and review of completed forms.

The data were entered into Microsoft Excel spreadsheets and subsequently imported into statistical software for analysis. Data entry was performed by trained personnel, and quality checks were conducted to identify and correct any data entry errors. The database was maintained with appropriate security measures to protect participant confidentiality.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were calculated for all variables. Categorical variables (blood groups, Rh factor, periodontal disease categories, gender) were summarized using frequencies and percentages. Continuous variables (age, periodontal parameters) were summarized using means and standard deviations.

Chi-square tests were employed to analyze associations between categorical variables, specifically to assess the relationship between ABO blood groups and periodontal disease categories, as well as associations with Rh factor, gender, and age groups. One-way Analysis of Variance (ANOVA) was used to compare mean periodontal parameter values (PI, GI, PPD, CAL) across different blood group categories. Independent samples t-tests were performed to compare periodontal parameters between males and females.

For all statistical tests, a p-value of less than 0.05 was considered statistically significant. All tests were two-tailed. Effect sizes were reported where appropriate to

provide additional context for the clinical significance of findings.

4. Results

Demographic Characteristics of Study Participants

The study included a total of 647 participants with a mean age of 35.2 ± 12.4 years (range: 18-60 years). The age distribution showed that the largest proportion of participants were in the 26-35 years age group (31.4%, n=203), followed by the 36-45 years group (28.7%, n=186), the 46-55 years group (20.1%, n=130), and the 18-25 years group (19.8%, n=128).

Regarding gender distribution, males comprised 52.4% (n=339) of the study population, while females constituted 47.6% (n=308). This near-equal gender distribution ensured that the study findings were representative of both male and female populations. (Table 1)

Distribution of ABO Blood Groups and Rh Factor

The distribution of ABO blood groups in the study population revealed that blood group O was the most prevalent, comprising 57.7% (n=373) of participants, followed by blood group B with 23.1% (n=149), blood group A with 13.8% (n=89), and blood group AB being the least prevalent at 2.3% (n=15).

When examining the detailed distribution including Rh factor, O+ was the most common blood type (56.3%, n=364), followed by B+ (22.1%, n=143), A+ (13.1%, n=85), AB+ (2.2%, n=14), O- (1.4%, n=9), B- (0.9%, n=6), A- (0.6%, n=4), and AB- (0.2%, n=1).

Regarding Rh factor distribution, the vast majority of participants were Rh-positive (96.9%, n=627), while only 3.1% (n=20) were Rh-negative. This distribution is consistent with general population genetics in the Indian subcontinent. (Table 2)

Distribution of Periodontal Disease Conditions

Analysis of periodontal status revealed that 40.0% (n=259) of participants presented with mild gingivitis (Group I), 35.4% (n=229) had moderate gingivitis (Group II), and 24.6% (n=159) were diagnosed with periodontitis (Group III). Thus, the combined prevalence of gingivitis (mild and moderate) was 75.4%, indicating a high burden of gingival inflammation in the study population.



The mean age of participants differed across periodontal disease categories. Participants with mild gingivitis had a mean age of 32.1 ± 10.8 years, those with moderate gingivitis had a mean age of 36.4 ± 12.3 years, and periodontitis patients had a mean age of 42.7 ± 11.9 years. This trend suggests an age-related increase in periodontal disease severity. (Table 3)

Association Between ABO Blood Groups and Periodontal Disease Status

Cross-tabulation analysis was performed to examine the distribution of periodontal disease conditions across different ABO blood groups. Among participants with mild gingivitis (Group I), blood group B showed the highest proportion (45.0%, n=67), followed by blood group O (39.7%, n=148), blood group A (35.9%, n=32), and blood group AB (40.0%, n=6).

In the moderate gingivitis group (Group II), blood group O demonstrated the highest proportion (36.7%, n=137), followed by blood group A (34.8%, n=31), blood group AB (33.3%, n=5), and blood group B (32.9%, n=49).

Among periodontitis patients (Group III), blood group A showed the highest proportion (29.2%, n=26), followed by blood group AB (26.7%, n=4), blood group O (23.6%, n=88), and blood group B (22.1%, n=33).

Chi-square analysis was performed to test the statistical significance of the association between ABO blood groups and periodontal disease status. The chi-square value obtained was 7.342 with 6 degrees of freedom, yielding a p-value of 0.290. This p-value is greater than the predetermined significance level of 0.05, indicating no statistically significant association between ABO blood groups and periodontal disease severity. (Table 4)

Comparison of Periodontal Parameters Across Blood Groups

Mean values of periodontal parameters including Plaque Index, Gingival Index, Probing Pocket Depth, and Clinical Attachment Level were calculated for each ABO blood group and compared using one-way ANOVA.

The mean Plaque Index values ranged from 1.76 ± 0.63 (blood group B) to 1.89 ± 0.72 (blood group AB). The mean Gingival Index values ranged from 1.86 ± 0.69 (blood group O) to 1.97 ± 0.79 (blood group AB). The mean Probing Pocket Depth ranged from 4.67 ± 1.28 mm (blood group B) to 4.91 ± 1.45 mm (blood group AB). The mean Clinical Attachment Level ranged from $3.21 \pm$

2.05 mm (blood group B) to 3.67 ± 2.34 mm (blood group AB).

ANOVA analysis revealed no statistically significant differences in any of the periodontal parameters across different blood groups. The F-values and corresponding p-values were: Plaque Index (F=0.672, p=0.569), Gingival Index (F=0.445, p=0.721), Probing Pocket Depth (F=0.894, p=0.443), and Clinical Attachment Level (F=0.672, p=0.569). (Table 5)

Distribution of Periodontal Conditions by Age Groups

The relationship between age and periodontal status was examined by cross-tabulating age groups with periodontal disease categories. In the 18-25 years age group, mild gingivitis was most prevalent (52.3%, n=67), followed by moderate gingivitis (35.2%, n=45) and periodontitis (12.5%, n=16).

In the 26-35 years age group, mild gingivitis remained most common (43.8%, n=89), followed by moderate gingivitis (37.4%, n=76) and periodontitis (18.7%, n=38). The 36-45 years age group showed a more even distribution with moderate gingivitis being most prevalent (38.2%, n=71), followed by mild gingivitis (36.6%, n=68) and periodontitis (25.3%, n=47).

In the 46-55 years age group, there was a notable shift with periodontitis being most prevalent (44.6%, n=58), followed by moderate gingivitis (28.5%, n=37) and mild gingivitis (26.9%, n=35). This clearly demonstrates an age-related progression from mild gingivitis in younger age groups to more severe periodontitis in older age groups.

Chi-square analysis revealed a statistically significant association between age groups and periodontal status ($\chi^2=42.67$, df=6, p<0.001), indicating that age is a significant factor influencing periodontal disease severity. (Table 6)

Distribution of Periodontal Conditions by Gender

The distribution of periodontal conditions was examined across gender groups. Among males, 39.5% (n=134) had mild gingivitis, 35.7% (n=121) had moderate gingivitis, and 24.8% (n=84) had periodontitis. Among females, 40.6% (n=125) had mild gingivitis, 35.1% (n=108) had moderate gingivitis, and 24.4% (n=75) had periodontitis.

Chi-square analysis showed no statistically significant association between gender and periodontal disease



status ($\chi^2=0.124$, $df=2$, $p=0.940$), suggesting that periodontal disease distribution was similar in both males and females in this study population.(Table 7)

Comparison of Periodontal Parameters by Gender

Mean periodontal parameters were compared between male and female participants using independent samples t-tests. Males had a mean Plaque Index of 1.78 ± 0.64 , Gingival Index of 1.85 ± 0.68 , Probing Pocket Depth of 4.69 ± 1.29 mm, and Clinical Attachment Level of 3.28 ± 2.08 mm.

Females had a mean Plaque Index of 1.81 ± 0.67 , Gingival Index of 1.92 ± 0.74 , Probing Pocket Depth of 4.78 ± 1.34 mm, and Clinical Attachment Level of 3.38 ± 2.17 mm. While females showed slightly higher mean values for all periodontal parameters, none of these differences reached statistical significance (all p-values >0.05).(Table 8)

Association Between Rh Factor and Periodontal Disease Status

The relationship between Rh factor and periodontal disease status was examined. Among Rh-positive individuals, 40.2% ($n=252$) had mild gingivitis, 35.2% ($n=221$) had moderate gingivitis, and 24.6% ($n=154$) had periodontitis. Among the small number of Rh-negative individuals, 35.0% ($n=7$) had mild gingivitis, 40.0% ($n=8$) had moderate gingivitis, and 25.0% ($n=5$) had periodontitis.

Chi-square analysis revealed no statistically significant association between Rh factor and periodontal disease status ($\chi^2=0.213$, $df=2$, $p=0.899$). However, the interpretation of this finding should be cautious given the small number of Rh-negative individuals in the sample.(Table 9)

In summary, the results of this comprehensive cross-sectional study involving 647 participants revealed no statistically significant association between ABO blood groups and periodontal disease severity. While certain observational trends were noted, including higher prevalence of blood group A in gingivitis groups and blood group O in periodontitis group, these differences did not reach statistical significance. Age was the only demographic variable that showed a statistically significant association with periodontal disease status, with older age groups demonstrating higher prevalence of severe periodontal disease.

5. Discussion

This comprehensive cross-sectional study examined the association between ABO blood groups and periodontal disease severity in a large, well-characterized sample of 647 individuals from South India. The primary finding of this investigation was that no statistically significant association exists between ABO blood group phenotypes and periodontal disease severity. While certain observational trends were noted, these did not reach statistical significance, suggesting that ABO blood groups may not serve as reliable predictors of periodontal disease susceptibility in this population.

Blood Group Distribution in the Study Population

The observed blood group distribution in this study, with O being most prevalent (57.7%), followed by B (23.1%), A (13.8%), and AB (2.3%), aligns closely with previous studies conducted in Indian populations [19,20,21]. This distribution reflects the characteristic genetic composition of South Indian communities, where blood group O typically predominates. The predominance of Rh-positive individuals (96.9%) is also consistent with global population genetics and findings from other regional studies conducted in India [2,9,10,16].

This blood group distribution pattern has been consistently reported in multiple studies from different regions of India, suggesting genetic homogeneity in ABO blood group frequencies across the Indian subcontinent. The relatively low frequency of AB blood group observed in this study (2.3%) is typical of most populations worldwide, as AB is the result of co-inheritance of both A and B alleles, which is statistically less common.

Periodontal Disease Prevalence and Distribution

The high prevalence of gingivitis observed in this study, with 75.4% of participants showing either mild or moderate gingivitis, reflects the substantial burden of periodontal disease in the Indian population [8,14,15,28]. This finding is consistent with national epidemiological surveys that have consistently reported widespread periodontal conditions in India, emphasizing the need for enhanced preventive strategies and improved oral health awareness programs.

The prevalence of periodontitis in this study (24.6%) falls within the range reported in other studies from India and is comparable to global estimates of moderate to severe periodontitis in adults [2,3,28]. This high prevalence



underscores the importance of understanding risk factors for periodontal disease, including potential genetic predisposition factors.

The age-related progression of periodontal disease observed in this study, with younger individuals showing predominantly gingivitis and older individuals showing higher prevalence of periodontitis, is well established in periodontal epidemiology. This pattern reflects the cumulative nature of periodontal destruction over time and the chronic progressive character of periodontal diseases.

Lack of Association Between ABO Blood Groups and Periodontal Disease

Despite observational trends suggesting that blood group A individuals might have higher prevalence in gingivitis groups and blood group O individuals showing increased association with periodontitis, statistical analysis failed to demonstrate significant associations. The chi-square value of 7.342 with a p-value of 0.290 clearly indicates no statistically significant relationship between ABO blood groups and periodontal disease severity in this population.

These findings align with several previous investigations that reported no significant correlations between ABO blood groups and periodontal diseases [9,10,11,12,16,17]. A recent cross-sectional study by Al-Askar et al. from Saudi Arabia, involving 416 participants, similarly found no significant association between ABO blood groups and periodontal diseases [9]. Likewise, Demir et al., in a large Turkish study of 1,351 subjects, reported no significant relationship between ABO blood types and periodontal status [10].

Gautam et al., in an observational study from India, also concluded that while certain trends were observed, no statistically significant association existed between ABO blood group phenotypes and periodontal disease [12]. These consistent findings across different populations and geographic regions suggest that the lack of association observed in the present study is not simply a result of population-specific factors.

However, it is important to note that some investigations have reported conflicting results. Pai et al., in a study from South Kanara district of Karnataka (the same state as the present study), reported a significant correlation between periodontal disease and ABO blood groups [19]. Similarly, Koregol et al. suggested that ABO blood groups and Rhesus factor could constitute risk predictors

in the development of periodontal disease [17]. The systematic review and meta-analysis by Al-Askar suggested possible associations but emphasized the need for larger, well-designed studies to establish definitive conclusions [18].

Role of Blood Group Antigens in Microbial Colonization and Host Response

Recent research has demonstrated that the host's immune response to periodontal pathogens is mediated by complex genetic factors, and this gene-pathogen interaction is considered fundamental to disease pathogenesis [4,5,6,14]. Studies have shown that different ABO blood groups may exhibit varying colonization rates of periodontal pathogens [11,14,25]. Blood group antigens expressed on epithelial surfaces may serve as receptors for bacterial adhesion, potentially influencing the composition and virulence of the oral microbiome.

The microbial complexes in subgingival plaque, particularly the red complex pathogens consisting of *Porphyromonas gingivalis*, *Tannerella forsythia*, and *Treponema denticola*, play crucial roles in periodontal disease progression [14,15,25]. These organisms possess various adhesins and virulence factors that may interact with host cell surface molecules, including blood group antigens. However, the complexity of the oral microbiome, which comprises hundreds of bacterial species with intricate ecological relationships, means that the influence of blood group antigens on overall microbial community structure may be modest.

Furthermore, the concept of periodontal diseases as polymicrobial disruptions of host homeostasis suggests that the relationship between ABO blood groups and disease susceptibility may be more complex than initially hypothesized [19,20,22,23]. The dysbiotic microbial communities in periodontitis interact with host genetic factors through multiple pathways involving innate immunity, adaptive immunity, and inflammatory responses. These interactions may be influenced more strongly by genetic variations in immune response genes than by ABO blood group phenotypes.

Genetic Susceptibility Beyond ABO Blood Groups

While this study focused specifically on ABO blood group associations, it is important to acknowledge that genetic susceptibility to periodontitis involves numerous other genetic factors that may be more relevant [4,6,26,27]. Research over the past two decades has identified polymorphisms in genes encoding inflammatory



mediators (including IL1B, IL1RN, IL6, and IL10), pattern recognition receptors (such as TLR4 and CD14), vitamin D receptors (VDR), and matrix metalloproteinases (MMP1, MMP3, MMP8, MMP9) as potentially associated with periodontal disease susceptibility in various populations [4,6,23,26,27].

Genome-wide association studies have identified specific genetic loci, such as GLT6D1, that show stronger associations with periodontitis than ABO blood groups [26]. These findings suggest that future research should focus on more functionally relevant genetic markers rather than relying on traditional genetic markers like blood groups.

The multifactorial nature of periodontal diseases necessitates a broader perspective on genetic risk factors, considering that individual genetic variants typically contribute only small portions to overall disease risk [5,6,12]. The interaction between multiple genetic variants and environmental factors likely determines an individual's true susceptibility to periodontal disease, and simple single-gene markers may have limited predictive value.

Comparison with Previous Studies and Methodological Considerations

The discrepancy in findings across different studies investigating ABO blood groups and periodontal disease may be attributed to several methodological factors [17,18,19,20]. Varying sample sizes across studies may affect statistical power to detect associations. While some earlier studies had relatively small sample sizes (less than 200 participants), the present study with 647 participants had adequate statistical power to detect even moderate effect sizes.

Different population groups and geographic locations may have different genetic backgrounds and environmental exposures that modify the relationship between blood groups and periodontal disease [19,20,21]. Genetic association studies are known to produce population-specific results, and findings from one population may not be directly applicable to another.

Study Limitations

Limitations of this study should be acknowledged. The cross-sectional design limits the ability to make causal inferences about the temporal relationship between blood groups and periodontal disease development. A single-center study conducted at one tertiary dental care

institution in South India, generalizability to other populations or geographic regions may be limited. The study population may not be representative of all Indian populations or other ethnic groups, and findings should be validated in other populations before drawing broad conclusions.

6. Conclusion:

While this study did not establish significant associations between ABO blood groups and periodontal diseases, the investigation contributes valuable information to the ongoing discussion about genetic factors in periodontal disease susceptibility. The findings suggest that routine ABO blood group determination is unlikely to provide clinically useful information for periodontal disease risk assessment in this population.

However, understanding genetic predisposition factors remains important for developing personalized periodontal therapy approaches [4,5,6,23]. As genetic testing technologies become more accessible and affordable, future clinical applications may involve comprehensive genetic risk profiling using multiple markers rather than relying on single genetic factors like blood groups.

The role of inflammation and genetics in periodontal disease is increasingly recognized as complex and multifaceted, involving immune fitness, microbial ecology, and epigenetic modifications [5,6,20,22]. This complexity suggests that single genetic markers, including ABO blood groups, are unlikely to serve as reliable predictors of disease risk in isolation. Instead, polygenic risk scores incorporating multiple genetic variants may provide better predictive value.

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PHOTOGRAPHS :

FIGURE 1





FIGURE 2



FIGURE 3



FIGURE 4

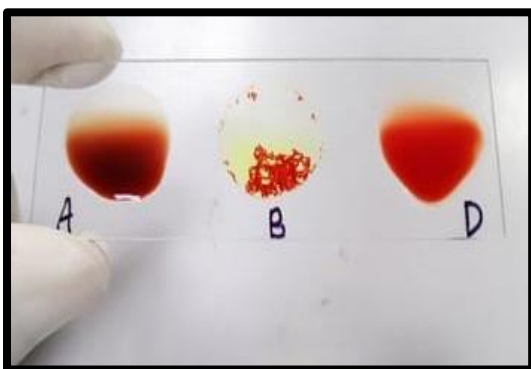


Table 1. Demographic characteristics of study participants (n=647)

| Characteristic | Frequency (n) | Percentage (%) |
|----------------------------|---------------|----------------|
| Age Groups | | |
| 18-25 years | 128 | 19.8 |
| 26-35 years | 203 | 31.4 |
| 36-45 years | 186 | 28.7 |
| 46-55 years | 130 | 20.1 |
| Gender Distribution | | |
| Male | 339 | 52.4 |

| Characteristic | Frequency (n) | Percentage (%) |
|----------------|---------------|----------------|
| Female | 308 | 47.6 |
| Total | 647 | 100.0 |

Table 2. Distribution of ABO blood groups and Rh factor in study population

| Blood Group | Frequency (n) | Percentage (%) |
|-------------------------------------|---------------|----------------|
| Detailed ABO-Rh Distribution | | |
| A+ | 85 | 13.1 |
| A- | 4 | 0.6 |
| B+ | 143 | 22.1 |
| B- | 6 | 0.9 |
| AB+ | 14 | 2.2 |
| AB- | 1 | 0.2 |
| O+ | 364 | 56.3 |
| O- | 9 | 1.4 |
| Rh Factor Distribution | | |
| Rh Positive | 627 | 96.9 |
| Rh Negative | 20 | 3.1 |
| ABO Blood Groups (Combined) | | |
| A | 89 | 13.8 |
| B | 149 | 23.1 |
| AB | 15 | 2.3 |
| O | 373 | 57.7 |
| Total | 647 | 100.0 |

Table 3. Distribution of periodontal conditions among study participants

| Periodontal Status | Frequency (n) | Percentage (%) | Mean Age (years) | Standard Deviation |
|--------------------------|---------------|----------------|------------------|--------------------|
| Group I: Mild Gingivitis | 259 | 40.0 | 32.1 | 10.8 |



| Periodontal Status | Frequency (n) | Percentage (%) | Mean Age (years) | Standard Deviation |
|-------------------------------|---------------|----------------|------------------|--------------------|
| Group II: Moderate Gingivitis | 229 | 35.4 | 36.4 | 12.3 |
| Group III: Periodontitis | 159 | 24.6 | 42.7 | 11.9 |
| Total | 647 | 100.0 | 35.2 | 12.4 |

Table 4. Cross-tabulation of ABO blood groups with periodontal disease conditions

| Blood Group | Mild Gingivitis | Moderate Gingivitis | Periodontitis | Total |
|--------------|-------------------|---------------------|-------------------|--------------------|
| | n (%) | n (%) | n (%) | n (%) |
| A | 32 (35.9) | 31 (34.8) | 26 (29.2) | 89 (13.8) |
| B | 67 (45.0) | 49 (32.9) | 33 (22.1) | 149 (23.1) |
| AB | 6 (40.0) | 5 (33.3) | 4 (26.7) | 15 (2.3) |
| O | 148 (39.7) | 137 (36.7) | 88 (23.6) | 373 (57.7) |
| Total | 259 (40.0) | 229 (35.4) | 159 (24.6) | 647 (100.0) |

$\chi^2 = 7.342$, $df = 6$, $p = 0.290$ (Not Significant)

Table 5. Comparison of mean periodontal parameters across ABO blood groups

| Blood Group | n | Plaque Index | Gingival Index | PPD (mm) | CAL (mm) |
|-------------|----|-----------------|-----------------|-----------------|-----------------|
| | | Mean \pm SD | Mean \pm SD | Mean \pm SD | Mean \pm SD |
| A | 89 | 1.84 \pm 0.67 | 1.92 \pm 0.74 | 4.82 \pm 1.34 | 3.45 \pm 2.18 |

| Blood Group | n | Plaque Index | Gingival Index | PPD (mm) | CAL (mm) |
|----------------|-----|-----------------|-----------------|-----------------|-----------------|
| B | 149 | 1.76 \pm 0.63 | 1.88 \pm 0.71 | 4.67 \pm 1.28 | 3.21 \pm 2.05 |
| AB | 15 | 1.89 \pm 0.72 | 1.97 \pm 0.79 | 4.91 \pm 1.45 | 3.67 \pm 2.34 |
| O | 373 | 1.79 \pm 0.65 | 1.86 \pm 0.69 | 4.73 \pm 1.31 | 3.32 \pm 2.12 |
| F-value | | 0.672 | 0.445 | 0.894 | 0.672 |
| p-value | | 0.569 | 0.721 | 0.443 | 0.569 |

PPD: Probing Pocket Depth; CAL: Clinical Attachment Level; SD: Standard Deviation

Table 6. Distribution of periodontal conditions across age groups

| Age Group | Mild Gingivitis | Moderate Gingivitis | Periodontitis | Total |
|--------------|-------------------|---------------------|-------------------|--------------------|
| | n (%) | n (%) | n (%) | n (%) |
| 18-25 years | 67 (52.3) | 45 (35.2) | 16 (12.5) | 128 (19.8) |
| 26-35 years | 89 (43.8) | 76 (37.4) | 38 (18.7) | 203 (31.4) |
| 36-45 years | 68 (36.6) | 71 (38.2) | 47 (25.3) | 186 (28.7) |
| 46-55 years | 35 (26.9) | 37 (28.5) | 58 (44.6) | 130 (20.1) |
| Total | 259 (40.0) | 229 (35.4) | 159 (24.6) | 647 (100.0) |

$\chi^2 = 42.67$, $df = 6$, $p < 0.001^*$ (*Statistically significant)

Table 7. Distribution of periodontal conditions by gender

| Gender | Mild Gingivitis | Moderate Gingivitis | Periodontitis | Total |
|--------|-----------------|---------------------|---------------|-------|
| | n (%) | n (%) | n (%) | n (%) |



| Gender | Mild Gingivitis | Moderate Gingivitis | Periodontitis | Total |
|--------------|-----------------|---------------------|---------------|-------------|
| Male | 134 (39.5) | 121 (35.7) | 84 (24.8) | 339 (52.4) |
| Female | 125 (40.6) | 108 (35.1) | 75 (24.4) | 308 (47.6) |
| Total | 259 (40.0) | 229 (35.4) | 159 (24.6) | 647 (100.0) |

$\chi^2 = 0.124$, $df = 2$, $p = 0.940$ (Not Significant)

Table 8. Comparison of mean periodontal parameters by gender

| Gender | n | Plaque Index | Gingival Index | PPD (mm) | CAL (mm) |
|----------------|-----|-----------------|-----------------|-----------------|-----------------|
| | | Mean \pm SD | Mean \pm SD | Mean \pm SD | Mean \pm SD |
| Male | 339 | 1.78 \pm 0.64 | 1.85 \pm 0.68 | 4.69 \pm 1.29 | 3.28 \pm 2.08 |
| Female | 308 | 1.81 \pm 0.67 | 1.92 \pm 0.74 | 4.78 \pm 1.34 | 3.38 \pm 2.17 |
| t-value | | -0.578 | -1.246 | -0.867 | -0.598 |
| p-value | | 0.563 | 0.213 | 0.386 | 0.550 |

PPD: Probing Pocket Depth; CAL: Clinical Attachment Level; SD: Standard Deviation

Table 9. Distribution of periodontal conditions by Rh factor

| Rh Factor | Mild Gingivitis | Moderate Gingivitis | Periodontitis | Total |
|-----------|-----------------|---------------------|---------------|------------|
| | n (%) | n (%) | n (%) | n (%) |
| Positive | 252 (40.2) | 221 (35.2) | 154 (24.6) | 627 (96.9) |
| Negative | 7 (35.0) | 8 (40.0) | 5 (25.0) | 20 (3.1) |

| Rh Factor | Mild Gingivitis | Moderate Gingivitis | Periodontitis | Total |
|--------------|-----------------|---------------------|---------------|-------------|
| Total | 259 (40.0) | 229 (35.4) | 159 (24.6) | 647 (100.0) |

$\chi^2 = 0.213$, $df = 2$, $p = 0.899$ (Not Significant)