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Possible relationship between blood groups and impacted lower third molars categorized according to the Pell and Gregory and the Winter classifications

Moguća povezanost krvnih grupa i impaktiranih donjih trećih molara kategorisanih prema Pell i Gregory i Winter klasifikacijama

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Abstract

Background/Aim. Teeth that fail to reach their normal position within the jaws are considered to be impacted, and the etiology of impacted teeth is multifactorial. The aim of this study was to examine the possible relationship between blood groups and classifications of impacted lower third molars (LTMs) according to the Pell and Gregory and the Winter classifications. **Methods.** This retrospective, cross-sectional study included 534 patients (274 males and 260 females) with at least one impacted LTM. A total of 890 LTMs were assessed using panoramic radiographs. Teeth were classified based on the Pell and Gregory and the Winter classifications, and blood groups were documented for each patient. Statistical analysis was performed using Fisher-Freeman-Halton test and Fisher's exact test, with the Bonferroni correction *Z* test for multiple comparisons. **Results.** Significant relationships were identified between blood groups and the Pell and Gregory classification ($p = 0.008$), but not with the Winter classification. Notably, women with A Rh-negative (Rh-), AB Rh-, and B Rh- blood groups exhibited higher prevalence rates for the I/B, I/C, and III/C positions, respectively. Additionally, women with A Rh-positive (Rh+) and O Rh+ blood groups demonstrated higher prevalence rates for the II/A position, while men with A Rh+ showed higher rates for the II/C position. Gender-specific differences in impaction patterns were observed for A Rh+ and O Rh+ blood groups ($p = 0.006$, $p = 0.038$, respectively). **Conclusion.** Blood group antigens might influence LTM impaction patterns, particularly in relation to the Pell and Gregory classification.

Keywords:
blood group antigens; molar, third; radiography, panoramic; tooth, impacted.

Apstrakt

Uvod/Cilj. Zubi koji ne dostignu svoj normalan položaj u vilicama smatraju se impaktiranim, a etiologija impaktiranih zuba ima više uzroka. Cilj rada bio je da se ispita moguća povezanost između krvnih grupa i impaktiranih donjih trećih molara (*lower third molars* – LTM) kategorisanih prema Pell i Gregory i Winter klasifikacijama. **Metode.** Ova retrospektivna, studija preseka obuhvatila je 534 pacijenta (274 muškarca i 260 žena) sa najmanje jednim impaktiranim LTM. Ukupno je analizirano 890 impaktiranih LTM pomoću panoramske radiografije. Zubi su klasifikovani prema Pell i Gregory i Winter klasifikacijama, a krvne grupe su zabeležene za svakog pacijenta. Statistička analiza sprovedena je korišćenjem Fisher-Freeman-Halton-ovog testa i Fisher-ovog egzaktnog testa, uz Bonferroni-jevu korekciju *Z* testa za višestruka poređenja. **Rezultati.** Utvrđena je značajna povezanost između krvnih grupa i Pell i Gregory klasifikacije ($p = 0{,}008$), ali ne i povezanost sa Winter klasifikacijom. Posebno je uočeno da su žene sa krvnim grupama A Rh-negativnom (Rh-), AB Rh- i B Rh- pokazale višu prevalenciju za pozicije I/B, I/C i III/C, redom. Takođe, žene sa krvnim grupama A Rh-pozitivnom (Rh+) i O Rh+ imale su više stope učestalosti za poziciju II/A, dok su muškarci sa A Rh+ krvnom grupom imali višu stopu učestalosti za poziciju II/C. Polno specifične razlike u obrascima impakcije primećene su kod krvnih grupa A Rh+ i O Rh+ ($p = 0{,}006$, $p = 0{,}038$, redom). **Zaključak.** Antigeni krvnih grupa mogu uticati na obrasce impakcije LTM, posebno u odnosu na Pell i Gregory klasifikaciju.

Ključne reči:
krvne grupe, antıgeni; molar, treći; ortopantomografija; zub, impakcija.

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Introduction

Tooth impaction is defined as the failure of a tooth to erupt into its normal functional position in the dental arch, and this condition occurs most frequently in the region of the lower third molars (LTMs) [1, 2]. The impaction of LTMs can be diagnosed during both routine dental examinations and the treatment of another tooth or teeth coincidentally [3, 4]. The impaction of LTMs can be associated with insufficient space, limited skeletal growth, reduced vertical condylar growth, increased crown dimension, delayed maturation of third molars, local factors, and certain systemic conditions (e.g., cleidocranial dysplasia, Down syndrome) [5, 6]. Furthermore, genetic factors may be linked with tooth impaction according to many previous studies [7].

Numerous classification systems have been proposed for impacted LTMs (ILTMs) to evaluate their angulation and extraction difficulty. Among these, the Winter and the Pell and Gregory classifications are the most preferred [8]. According to the Winter classification, the LTMs are categorized based on the angle formed between their longitudinal axis and that of the adjacent second molar as mesioangular, distoangular, horizontal, vertical, or inverted [9]. Concerning the relationship to the anterior margin of the mandibular ramus, the Pell and Gregory classification is performed to understand the level (depth) of the occlusal plane and the difficulty of impaction of the LTM [10].

A number of studies have demonstrated a correlation between blood groups (BGs) and the occurrence of various diseases [11, 12]. The ABO classification and Rhesus (Rh) system are the most commonly used around the world. The ABO classification comprises four blood groups (A, B, O, and AB) and is based on the presence or absence of A and B antigens on the surface of red blood cells. Specifically, blood group A is characterized by the presence of the A antigen, blood group B by the presence of the B antigen, blood group AB by the presence of both A and B antigens, and blood group O by the absence of both antigens [13]. In contrast, the Rh system is a classification system that categorizes groups according to the presence or absence of the RhD antigen on the red blood cell membrane. If a red blood cell presents the RhD antigen, it is designated as Rh-positive (Rh+), while if it does not, it is designated as Rh-negative (Rh-) [14].

Previous studies have reported associations between BGs and various medical and dental conditions, including cancer, cardiovascular disease, and dental caries [15–17]. However, a limited number of studies have examined the possible association between BGs and oral diseases. With respect to this matter, the evidence indicated that considering BGs separately, AB individuals have a greater risk of developing early childhood dental caries compared with individuals of other BGs [15, 18].

A great deal of controversy and inconsistency remains concerning the possible significance of BGs, specifically those of ABO system, as either diagnostic or prognostic factors in the context of oral and dental diseases, especially due to the diversity of methodological approaches employed in the various studies. Additionally, the varying geographical distributions and genetic profiles of BGs in different populations may contribute to the observed discrepancies [19]. The association between impacted teeth and ABO and Rh types within BGs is of great importance in predicting which populations are more susceptible to developing impacted third molars.

The aim of this study was to examine the possible relationship between ILTM classifications and BGs.

Methods

Study design

This retrospective cross-sectional study was conducted on all patients referred to the Department of Oral Radiology, Faculty of Dentistry, Alanya Alaaddin Keykubat University, Türkiye, between May 1 and December 31, 2023. The study was approved by the Ethics Committee of the Faculty of Dentistry, Alanya Alaaddin Keykubat University (No. 10354421-2023/14-15, from October 18, 2023). All individuals participating in the study were informed verbally about the study and provided written informed consent.

The study population consisted of all patients who underwent panoramic radiographs for dental examination or treatment. Out of 8,880 patients, those older than 20 years with at least one ILTM with complete root development, with no systemic disease, and no radiological lesions such as cysts or tumors in the posterior mandibular area were included in our study.

Among these individuals, patients lacking a lower second molar in the relevant region, those with crown destruction of the mandibular second molar due to caries or other reasons, those with a history of orthodontic treatment, and those with any trauma or pathology that would affect the dentition were excluded from the study. Ultimately, 534 patients (274 males and 260 females) who met the inclusion criteria were enrolled in the study, contributing a total of 890 ILTMs, of which 454 were in males and 436 in females.

Measures and procedures

All panoramic radiographs were obtained by a single operator using standardized parameters (66 kV, 8 mA, exposure time 15.8 s) on a panoramic X-ray unit (ProMax® 2D S3, Planmeca, Helsinki, Finland), with a magnification factor set to 1. A patient informed consent form, designed specifically for use within the context of our study, was utilized to conduct interviews with the participants. The participants were examined by a single dental practitioner (G.I.T.) to ensure standardization and reliability in the evaluation process. This approach minimized inter-observer variability, particularly given that subjective interpretations were required for the classifications of third molars. Additionally, the dental practitioner was calibrated through a test-retest process, achieving a substantial agreement ($\kappa = 0.879$), which ensured consistency in applying the classification criteria across all participants. The radiographs were analyzed at the same time of day and on the same computer. During data collection, a 5-min rest period was taken after every 30 min of evaluating radiographs. This was done to prevent visual fatigue and to ensure the integrity of the process.

The collected data included the patient's gender, BG, classification of impacted third molars based on both the Pell and Gregory and the Winter classification systems, and the side (left or right) of the impacted tooth. BG (categorized as A, B, AB, or O) and Rh factor (positive or negative) were retrieved from medical documentation, the e-Nabız system (a digital health portal provided by the Turkish Ministry of Health), and driver's licenses. A tooth was defined as impacted if the occlusal surface of the LTM was positioned below the occlusal plane and partially embedded within the jawbone.

The ILTMs were evaluated using the Pell and Gregory classification system, which assesses the tooth's position based on two parameters: its vertical alignment relative to the adjacent second molar's occlusal plane, and the extent to which it is obstructed by the mandibular ramus.

Regarding the ramus relationship, Class I is identified when the space between the anterior border of the mandibular ramus and the distal surface of the second molar is wide enough to accommodate the full mesiodistal width of the third molar. Class II applies when the available space is smaller than the third molar's width, resulting in partial coverage of the tooth by the ramus. Class III indicates that the mandibular ramus entirely overlaps the area where the third molar would erupt, with no discernible gap between the ramus and the distal side of the second molar.

Regarding the vertical positioning relative to the second molar, position A denotes that the top surface (occlusal surface) of the third molar is at or above the level of the second molar's biting surface. Position B describes a scenario where the third molar lies between the occlusal surface and the cervical (neck) area of the second molar. Position C is used when the occlusal surface of the third molar is situated beneath the cervical margin of the second molar.

Additionally, the ILTMs were categorized according to the Winter classification, which is based on the angulation of the third molar in relation to the long axis of the second molar. This included vertical, mesioangular, horizontal, distoangular, and inverse positions. The buccoangular and linguoangular orientations were excluded from the analysis due to limitations in their accurate visualization on panoramic radiographs.

Statistical analysis

A sample size calculation was conducted using the G*Power software (latest version 3.1.9.7, Heinrich Heine University of Düsseldorf, Düsseldorf, Germany). The sample size was determined by utilizing the prevalence of impacted third molars by the Winter and the Pell and Gregory classification on radiographic assessment in relation to ABO BGs, which was published in a previous study [20]. All statistical analyses were performed using IBM SPSS Statistics version 23 (Chicago, USA) in a Windows environment. The Fisher-Freeman-Halton test and Fisher's exact test were employed to compare categorical data, with multiple comparisons analyzed by a Bonferroni-corrected *Z* test. The results of the analyses were presented in the form of a frequency table, with the corresponding percentage values. The significance level was set at $p < 0.05$.

Based on the results of the reference study [20], the minimum number of ILTMs required for sampling was 835, as determined by the power analysis, with a 95% confidence level (1-α), a 95% power test (1-β), and an effect size of w: 0.198.

Results

Demographic characteristics

A total of 534 patients (274 males and 260 females) with a mean age of 30.8 ± 8.7 years (range: 20–73 years) were included in the study. Among the 890 ILTMs, 454 belonged to males and 436 to females. The teeth were nearly evenly distributed between the right (444 teeth) and left (446 teeth) sides. The distribution of BGs was as follows: A Rh+ 39.1%, O Rh+ 28.3%, B Rh+ 13.3%, AB Rh+ 5.8%, O Rh- 5.4%, A Rh- 5.1%, B Rh- 1.7%, and AB Rh- 1.3% (Table 1).

Table 1

Demographic characteristics of the study population (n = 534)

Characteristics	Value
Gender	
male	274 (51.3)
female	260 (48.7)
Age, years	30.8 ± 8.7 (20–73)
Blood group	
A Rh+	39.1
O Rh+	28.3
B Rh+	13.3
AB Rh+	5.8
O Rh-	5.4
A Rh-	5.1
B Rh-	1.7
AB Rh-	1.3

All values are given as numbers (percentages), except for age, which is shown as mean ± standard deviation (range).

Classification of ımpacted teeth

In accordance with the Pell and Gregory classification, the most prevalent position was II/B (36.85%), followed by II/A (33.14%), and the least prevalent was III/A (1.01%). Concerning the Winter classification, the most common angulation was mesioangular (28.36%), followed by vertical (27.57%), and the least common was inverted (1.56%) (Table 2).

Relationships between classifications and blood groups

No statistically significant relationship was observed between BGs and classes in the Winter classification, regardless of gender or side ($p = 0.476$) (Table 3).

In contrast, a statistically significant relationship was found between BGs and ILTMs in the Pell and Gregory classification, regardless of gender or side ($p = 0.008$) (Table 4).

Table 2

Distribution of impacted lower third molars by the Pell and Gregory and the Winter classifications

Classification/Position	Prevalence (%)
Pell and Gregory	
II/B	36.85
II/A	33.14
I/A	8.31
II/C	6.85
III/B	5.39
I/B	3.25
III/C	2.92
I/C	2.24
III/A	1.01
Winter	
mesioangular	28.36
vertical	27.57
distoangular	23.87
horizontal	18.60
inverted	1.56

Table 3

Comparison of the Winter classification classes by blood groups for right and left sides, and overall distribution without gender distinction

Side/Class	Blood group								Test statistic	*p-value
	A Rh+	A Rh-	B Rh+	B Rh-	O Rh+	O Rh-	AB Rh+	AB Rh-		
Right										
mesioangular	49 (28.3)	8 (34.8)	16 (26.7)	2 (28.6)	30 (22.7)	8 (32.0)	7 (30.4)	0 (0)	18.315	0.940
distoangular	40 (23.1)	4 (17.4)	18 (30.0)	1 (14.3)	34 (26.2)	5 (20.0)	3 (13.0)	2 (66.7)		
vertical	41 (23.7)	5 (21.7)	17 (28.3)	2 (28.6)	36 (27.3)	9 (36.0)	6 (26.1)	0 (0)		
horizontal	40 (23.1)	6 (26.1)	9 (15.0)	2 (28.6)	27 (20.5)	3 (12.0)	7 (30.4)	1 (33.3)		
inverted	3 (1.7)	0 (0)	0 (0)	0 (0)	3 (2.3)	0 (0)	0 (0)	0 (0)		
total	173 (100)	23 (100)	60 (100)	7 (100)	130 (100)	25 (100)	23 (100)	3 (100)		
Left										
mesioangular	58 (35.4)	4 (18.2)	16 (27.1)	1 (12.5)	40 (30.1)	6 (24.0)	7 (24.1)	1 (16.7)	30.026	0.268
distoangular	32 (19.5)	3 (13.6)	13 (22.0)	0 (0)	34 (25.6)	6 (24.0)	13 (44.8)	3 (50.0)		
vertical	45 (27.4)	10 (45.5)	21 (35.6)	3 (37.5)	37 (27.8)	9 (36.0)	4 (13.8)	1 (16.7)		
horizontal	26 (15.9)	5 (22.7)	8 (13.6)	4 (50.0)	20 (15.0)	3 (12.0)	4 (13.8)	1 (16.7)		
inverted	3 (1.8)	0 (0)	1 (1.7)	0 (0)	2 (1.5)	1 (4.0)	1 (3.4)	0 (0)		
total	164 (100)	22 (100)	59 (100)	8 (100)	133 (100)	25 (100)	29 (100)	6 (100)		
Total										
mesioangular	107 (31.8)	12 (26.7)	32 (26.9)	3 (20.0)	70 (26.4)	14 (28.0)	14 (26.9)	1 (11.1)	26.504	0.476
distoangular	72 (21.4)	7 (15.6)	31 (26.1)	1 (6.7)	68 (26.4)	11 (22.0)	16 (30.8)	5 (55.6)		
vertical	86 (25.5)	15 (33.3)	38 (31.9)	5 (33.3)	73 (27.5)	18 (36.0)	10 (19.2)	1 (11.1)		
horizontal	66 (19.6)	11 (24.4)	17 (14.3)	6 (40.0)	47 (17.7)	6 (12.0)	11 (21.2)	2 (22.2)		
inverted	6 (1.8)	0 (0)	1 (0.8)	0 (0)	5 (1.9)	1 (2.0)	1 (1.9)	0 (0)		
total	337 (100)	45 (100)	119 (100)	15 (100)	263 (100)	50 (100)	52 (100)	9 (100)		

All values are given as numbers (percentages).

***Note*: * Fisher-Freeman-Halton test was used.**

Table 4

Sample distribution by the Pell and Gregory classification across blood groups, regardless of gender or side

Scale/Class	Blood group								Test statistic	*p-value
	A Rh+	A Rh-	B Rh+	B Rh-	O Rh+	O Rh-	AB Rh+	AB Rh-		
Right										
I/A	15 (8.7)	2 (8.7)	6 (10.0)	0 (0)	10 (7.7)	7 (28.0)	1 (4.3)	0 (0)		
I/B	3 (1.7)	2 (8.7)	3 (5.0)	0 (0)	2 (1.5)	1 (4.0)	2 (8.7)	0 (0)		
I/C	2 (1.2)	0 (0)	2 (3.3)	0 (0)	1 (0.8)	0 (0)	0 (0)	0 (0)		
II/A	63 (36.4)	4 (17.4)	20 (33.3)	4 (57.1)	51 (39.2)	9 (36.0)	7 (30.4)	2 (66.7)		
II/B	54 (31.2)	10 (43.5)	25 (41.7)	2 (28.6)	46 (35.4)	7 (28.0)	9 (39.1)	1 (33.3)	62.671	0.134
II/C	17 (9.8)	0 (0)	0 (0)	0 (0)	9 (6.9)	0 (0)	1 (4.3)	0 (0)		
III/A	2 (1.2)	0 (0)	0 (0)	0 (0)	2 (1.5)	0 (0)	0 (0)	0 (0)		
III/B	12 (6.9)	3 (13.0)	3 (5.0)	0 (0)	8 (6.2)	1 (4.0)	0 (0)	0 (0)		
III/C	5 (2.9)	2 (8.7)	1 (1.7)	1 (14.3)	1 (0.8)	0 (0)	3 (13.0)	0 (0)		
total	173 (100)	23 (100)	60 (100)	7 (100)	130 (100)	25 (100)	23 (100)	3 (100)		
Left										
I/A	15 (9.1)	0 (0)	2 (3.4)	0 (0)	10 (7.5)	3 (12)	3 (10.3)	0 (0)		
I/B	3 (1.8)	2 (9.1)	3 (5.1)	1 (12.5)	5 (3.8)	2 (8.0)	0 (0)	0 (0)		
I/C	3 (1.8)	0 (0)	3 (5.1)	0 (0)	8 (6)	0 (0)	0 (0)	1 (16.7)		
II/A	56 (34.1)	9 (40.9)	13 (22.0)	4 (50.0)	35 (26.3)	7 (28.0)	10 (34.5)	1 (16.7)		
II/B	57 (34.8)	6 (27.3)	28 (47.5)	2 (25.0)	56 (42.1)	11 (44.0)	12 (41.4)	2 (33.3)	59.421	0.137
II/C	14 (8.5)	2 (9.1)	6 (10.2)	0 (0)	9 (6.8)	2 (8.0)	1 (3.4)	0 (0)		
III/A	2 (1.2)	2 (9.1)	0 (0)	0 (0)	1 (0.8)	0 (0)	0 (0)	0 (0)		
III/B	8 (4.9)	0 (0)	3 (5.1)	0 (0)	8 (6.0)	0 (0)	0 (0)	2 (33.3)		
III/C	6 (3.7)	1 (4.5)	1 (1.7)	1 (12.5)	1 (0.8)	0 (0)	3 (10.3)	0 (0)		
total	164 (100)	22 (100)	59 (100)	8 (100)	133 (100)	25 (100)	29 (100)	6 (100)		
Total										
I/A	30 (8.9)	2 (4.4)	8 (6.7)	0 (0)	20 (7.6)	10 (20.0)	4 (7.7)	0 (0)		
I/B	6 (1.8)	4 (8.9)	6 (5.0)	1 (6.7)	7 (2.7)	3 (6.0)	2 (3.8)	0 (0)		
I/C	5 (1.5)	0 (0)	5 (4.2)	0 (0)	9 (3.4)	0 (0)	0 (0)	1 (11.1)		
II/A	119 (35.3)	13 (28.9)	33 (27.7)	8 (53.3)	86 (32.7)	16 (32.0)	17 (32.7)	3 (33.3)		
II/B	111 (32.9)	16 (35.6)	53 (44.5)	4 (26.7)	102 (38.8)	18 (36.0)	21 (40.4)	3 (33.3)	75.721	**0.008**
II/C	31 (9.2)	2 (4.4)	6 (5.0)	0 (0)	18 (6.8)	2 (4.0)	2 (3.8)	0 (0)		
III/A	4 (1.2)	2 (4.4)	0 (0)	0 (0)	3 (1.1)	0 (0)	0 (0)	0 (0)		
III/B	20 (5.9)[ab]	3 (6.7)[ab]	6 (5.0)[ab]	0 (0)[ab]	16 (6.1)[ab]	1 (2.0)[ab]	0 (0)[b]	2 (22.2)[a]		
III/C	11 (3.3)[abc]	3 (6.7)[abc]	2 (1.7)[abc]	2 (13.3)[c]	2 (0.8)[b]	0 (0)[abc]	6 (11.5)[ac]	0 (0)[abc]		
total	337 (100)	45 (100)	119 (100)	15 (100)	263 (100)	50 (100)	52 (100)	9 (100)		

All values are given as numbers (percentages). Bold values indicate statistical significance, *p* < 0.05.
***Note*: * Fisher-Freeman-Halton test was used; [a-c] there was no difference between groups with the same letter.**

Gender-specific analyses

Separate analyses were conducted to investigate the relationships between BGs and classifications of ILTMs in males and females, across both the Pell and Gregory and the Winter classification systems.

For females, a statistically significant relationship was found between BGs and classifications in the Pell and Gregory system, regardless of the side ($p = 0.041$) (Table 5).

No statistically significant relationships were found in the Winter classification for females ($p > 0.05$).

For males, no statistically significant relationships were identified between BGs and classifications in either the Pell and Gregory or the Winter classification systems, regardless of the side ($p > 0.05$).

Table 5

Female sample distribution by the Pell and Gregory classification across blood groups, regardless of side

Scale/Class	Blood group								Test statistic	*p-value
	A Rh+	A Rh-	B Rh+	B Rh-	O Rh+	O Rh-	AB Rh+	AB Rh-		
Right										
I/A	10 (10.5)	1 (12.5)	2 (6.3)	0 (0)	3 (4.7)	3 (25)	0 (0)	0 (0)		
I/B	1 (1.1)	1 (12.5)	2 (6.3)	0 (0)	1 (1.6)	1 (8.3)	1 (9.1)	0 (0)		
I/C	1 (1.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)		
II/A	38 (40.0)	2 (25.0)	9 (28.1)	1 (33.3)	33 (51.6)	4 (33.3)	4 (36.4)	2 (100)		
II/B	33 (34.7)	3 (37.5)	17 (53.1)	1 (33.3)	19 (29.7)	4 (33.3)	5 (45.5)	0 (0)	63.334	0.390
II/C	4 (4.2)	0 (0)	0 (0)	0 (0)	4 (6.3)	0 (0)	0 (0)	0 (0)		
III/A	1 (1.1)	0 (0)	0 (0)	0 (0)	2 (3.1)	0 (0)	0 (0)	0 (0)		
III/B	4 (4.2)	1 (12.5)	1 (3.1)	0 (0)	2 (3.1)	0 (0)	0 (0)	0 (0)		
III/C	3 (3.2)	0 (0)	1 (3.1)	1 (33.3)	0 (0)	0 (0)	1 (9.1)	0 (0)		
total	95 (100)	8 (100)	32 (100)	3 (100)	64 (100)	12 (100)	11 (100)	2 (100)		

Table 5 (continued)

Scale/Class	Blood group								Test statistic	*p-value
	A Rh+	A Rh-	B Rh+	B Rh-	O Rh+	O Rh-	AB Rh+	AB Rh-		
Left										
I/A	8 (10.0)	0 (0)	2 (6.5)	0 (0)	3 (5.1)	1 (10.0)	2 (13.3)	0 (0)	67.538	0.130
I/B	1 (1.3)	1 (14.3)	2 (6.5)	0 (0)	1 (1.7)	1 (10.0)	0 (0)	0 (0)		
I/C	0 (0)	0 (0)	0 (0)	0 (0)	2 (3.4)	0 (0)	0 (0)	1 (25.0)		
II/A	35 (43.8)	4 (57.1)	5 (16.1)	2 (66.7)	17 (28.8)	4 (40.0)	5 (33.3)	1 (25.0)		
II/B	27 (33.8)	2 (28.6)	18 (58.1)	0 (0)	31 (52.5)	4 (40.0)	6 (40.0)	1 (25.0)		
II/C	4 (5.0)	0 (0)	2 (6.5)	0 (0)	3 (5.1)	0 (0)	1 (6.7)	0 (0)		
III/A	1 (1.3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)		
III/B	3 (3.8)	0 (0)	2 (6.5)	0 (0)	2 (3.4)	0 (0)	0 (0)	1 (25.0)		
III/C	1 (1.3)	0 (0)	0 (0)	1 (33.3)	0 (0)	0 (0)	1 (6.7)	0 (0)		
total	80 (100)	7 (100)	31 (100)	3 (100)	59 (100)	10 (100)	15 (100)	4 (100)		
Total										
I/A	18 (10.3)	1 (6.7)	4 (6.3)	0 (0)	6 (4.9)	4 (18.2)	2 (7.7)	0 (0)	68.123	**0.041**
I/B	2 (1.1)[a]	2 (13.3)[b]	4 (6.3)[ab]	0 (0)[ab]	2 (1.6)[ab]	2 (9.1)[ab]	1 (3.8)[ab]	0 (0)[ab]		
I/C	1 (0.6)[a]	0 (0)[ab]	0 (0)[a]	0 (0)[ab]	2 (1.6)[ab]	0 (0)[ab]	0 (0)[ab]	1 (16.7)[b]		
II/A	73 (41.7)	6 (40.0)	14 (22.2)	3 (50.0)	50 (40.7)	8 (36.4)	9 (34.6)	3 (50.0)		
II/B	60 (34.3)	5 (33.3)	35 (55.6)	1 (16.7)	50 (40.7)	8 (36.4)	11 (42.3)	1 (16.7)		
II/C	8 (4.6)	0 (0)	2 (3.2)	0 (0)	7 (5.7)	0 (0)	1 (3.8)	0 (0)		
III/A	2 (1.1)	0 (0)	0 (0)	0 (0)	2 (1.6)	0 (0)	0 (0)	0 (0)		
III/B	7 (4.0)	1 (6.7)	3 (4.8)	0 (0)	4 (3.3)	0 (0)	0 (0)	1 (16.7)		
III/C	4 (2.3)[a]	0 (0)[ab]	1 (1.6)[a]	2 (33.3)[b]	0 (0)[a]	0 (0)[ab]	2 (7.7)[ab]	0 (0)[ab]		
total	175 (100)	15 (100)	63 (100)	6 (100)	123 (100)	22 (100)	26 (100)	6 (100)		

All values are given as numbers (percentages). Bold values indicate statistical significance, *p* < 0.05.
***Note*: * Fisher-Freeman-Halton test was used; [a, b] there was no difference between groups with the same letter.**

Investigation of blood groups and ımpaction relationships

Each BG was investigated to compare impacted tooth subgroups according to gender, both with and without side discrimination. Among all BGs, A Rh+ and O Rh+ were the only ones that showed a statistically significant relationship between gender and impacted tooth subgroups. Importantly, this relationship was observed exclusively in the Pell and Gregory classification.

For the A Rh+ BG, a statistically significant relationship between gender and impacted tooth subgroups was identified without side discrimination (*p* = 0.006). These results are detailed in Table 6, where differences between males and females in specific subgroups are highlighted. For instance, significant differences were noted for Class II/A (males: 28.4%, females: 41.7%) and Class II/C (males: 14.2%, females: 4.6%), indicating notable gender-based variations within these subgroups.

For the O Rh+ BG, a similar statistically significant relationship was found (*p* = 0.038) (Table 7). These findings underscore the unique relevance of these two BGs in relation to ILTMs, as no other BG demonstrated significant associations.

Table 6

Comparison of impacted tooth subgroups by gender in the A Rh+ blood group based on the Pell and Gregory classification, considering sides and overall distribution

Scale/Class	Gender		Test statistic	*p-value
	male	female		
Right				
I/A	5 (6.4)	10 (10.5)	12.529	0.086
I/B	2 (2.6)	1 (1.1)		
I/C	1 (1.3)	1 (1.1)		
II/A	25 (32.1)	38 (40.0)		
II/B	21 (26.9)	33 (34.7)		
II/C	13 (16.7)	4 (4.2)		
III/A	1 (1.3)	1 (1.1)		
III/B	8 (10.3)	4 (4.2)		
III/C	2 (2.6)	3 (3.2)		
total	78 (100)	95 (100)		

Table 6 (continued)

Scale/Class	Gender		Test statistic	*p-value
	male	female		
Left				
I/A	7 (8.3)	8 (10.0)	12.408	0.097
I/B	2 (2.4)	1 (1.3)		
I/C	3 (3.6)	0 (0)		
II/A	21 (25.0)	35 (43.8)		
II/B	30 (35.7)	27 (33.8)		
II/C	10 (11.9)	4 (5.0)		
III/A	1 (1.2)	1 (1.3)		
III/B	5 (6.0)	3 (3.8)		
III/C	5 (6.0)	1 (1.3)		
total	84 (100)	80 (100)		
Total				
I/A	12 (7.4)	18 (10.3)	19.880	**0.006**
I/B	4 (2.5)	2 (1.1)		
I/C	4 (2.5)	1 (0.6)		
II/A	46 (28.4)[a]	73 (41.7)[b]		
II/B	51 (31.5)	60 (34.3)		
II/C	23 (14.2)[a]	8 (4.6)[b]		
III/A	2 (1.2)	2 (1.1)		
III/B	13 (8.0)	7 (4.0)		
III/C	7 (4.3)	4 (2.3)		
total	162 (100)	175 (100)		

All values are given as numbers (percentages).
Bold values indicate statistical significance, $p < 0.05$.
***Note*: * Fisher-Freeman-Halton test was used; [a, b] there was no difference between groups with the same letter.**

Table 7

Comparison of impacted tooth subgroups by gender in the O Rh+ blood group based on the Pell and Gregory classification, considering sides and overall distribution

Scale/Class	Gender		Test statistic	*p-value
	male	female		
Right				
I/A	7 (10.6)	3 (4.7)	13.068	0.051
I/B	1 (1.5)	1 (1.6)		
I/C	1 (1.5)	0 (0)		
II/A	18 (27.3)	33 (51.6)		
II/B	27 (40.9)	19 (29.7)		
II/C	5 (7.6)	4 (6.3)		
III/A	0 (0)	2 (3.1)		
III/B	6 (9.1)	2 (3.1)		
III/C	1 (1.5)	0 (0)		
total	66 (100)	64 (100)		
Left				
I/A	7 (9.5)	3 (5.1)	8.911	0.306
I/B	4 (5.4)	1 (1.7)		
I/C	6 (8.1)	2 (3.4)		
II/A	18 (24.3)	17 (28.8)		
II/B	25 (33.8)	31 (52.5)		
II/C	6 (8.1)	3 (5.1)		
III/A	1 (1.4)	0 (0)		
III/B	6 (8.1)	2 (3.4)		
III/C	1 (1.4)	0 (0)		
total	74 (100)	59 (100)		

Table 7 (continued)

Scale/Class	Gender		Test statistic	*p-value
	male	female		
Total				
I/A	14 (10)	6 (4.9)		
I/B	5 (3.6)	2 (1.6)		
I/C	7 (5.0)	2 (1.6)		
II/A	36 (25.7)[a]	50 (40.7)[b]		
II/B	52 (37.1)	50 (40.7)	15.133	**0.038**
II/C	11 (7.9)	7 (5.7)		
III/A	1 (0.7)	2 (1.6)		
III/B	12 (8.6)	4 (3.3)		
III/C	2 (1.4)	0 (0)		
total	140 (100)	123 (100)		

All values are given as numbers (percentages).
Bold values indicate statistical significance, $p < 0.05$.
***Note*: *Fisher-Freeman-Halton test was used; [a, b] there was no difference between groups with the same letter.**

Discussion

Teeth that fail to reach their normal position within the jaws at the expected time of eruption, for a variety of reasons, are considered to be impacted [21]. The etiology of impacted teeth is multifactorial, with numerous contributing factors. These include physical disintegration of the lamina of the teeth, insufficient space for the eruption of the teeth, a natural defect of the tooth lamina, and failure of the induction of the mesenchyme [22].

There is a paucity of data regarding potential differences in impaction incidence between genders, populations, age groups, and over time [2]. Although some researchers have reported a higher occurrence in females compared to males [23–25], a substantial body of literature indicates no statistically significant association between gender and the presence of impacted third molars [26–29]. These findings are consistent with the results of the present study. Similarly, the current results revealed no significant difference in the frequency of impaction between the right and left sides of the mandible, which aligns with observations reported in several other studies [23, 30, 31].

The LTMs have the highest incidence of impaction. In order to evaluate these teeth radiographically, it is necessary to determine the angulation of the molars according to the Winter classification, the level of depth in the bone, and the relationship of the teeth to the ramus of the mandible. Furthermore, the relationship of the second molars to the aforementioned structures should be determined according to the Pell and Gregory classification. Similar to the present study, mesioangular and inverted positions were observed to be the most and least prevalent, respectively, according to the Winter classification, as reported by Santos et al. [32]. In accordance with the Pell and Gregory classification, some authors have indicated that the C level is the most prevalent at the depth level [33], while others have suggested that the A level is the most common [34]. Previous research [35] reported that the most commonly observed level was B, consistent with the findings of this study. When considering the ramus of the mandible, although some authors have found that Position I is the most common position, followed by Position II [35], many studies have reported that Position II is the most common position [32, 36, 37]. This is similar to the present study. In contrast to prior study [38], which identified II/A as the most prevalent category followed by II/B within the Pell and Gregory classification, the present study yielded different results. In our study, the II/B position (36.85%) was the most prevalent, followed by II/A (33.14%).

The most common cause of impacted third molars is insufficient space for eruption, which has a genetic component. This raises the possibility of a potential link between BG and the occurrence of impacted third molars [39]. The association has been investigated previously. However, unlike the findings presented in the current research, Ahmadi et al. [40] did not demonstrate a statistically significant correlation between BGs and the presence of impacted teeth. The sample size and geographical distribution may have been responsible. In previous research [3], the prevalence of impacted teeth in both jaws was analyzed, and the existing impacted teeth were classified according to the Winter classification. In this study, given that the prevalence of impacted teeth was the highest, only impacted teeth in the lower jaw were evaluated, and all impacted teeth were grouped according to both the Pell and Gregory and the Winter classifications.

The significant association observed between BGs and impacted teeth according to the Pell and Gregory classification suggests a potential genetic or biological link. Among the different BGs, individuals with AB Rh- showed a higher prevalence of the III/B position, while those with B Rh- and AB Rh+ were more likely to present with the III/C position. These findings provide new insights into the possible role of genetic factors.

Gender-specific analyses revealed further distinctions. Women with A Rh- BG were more likely to present with the I/B position, while those with AB Rh- and B Rh- BGs were more likely to present with I/C and III/C positions, respectively. Additionally, women with A Rh+

and O Rh+ BGs exhibited higher prevalence rates for the II/A position, whereas men with A Rh+ showed higher rates for the II/C position. These findings could have significant clinical implications for identifying individuals at greater risk of specific impaction patterns based on their gender and BG.

This study's limitations warrant careful consideration. First, all evaluations were conducted by a single operator, which, while ensuring consistency, limits the inter-rater reliability of the findings. Future studies should involve multiple independent observers to enhance objectivity. Second, the exclusion of certain classification angles, such as bucoangular and distoangular, due to the limitations of panoramic radiography, may have excluded relevant data. Third, the study design did not include a *post hoc* power analysis, which could have further strengthened the statistical robustness of the findings. Moreover, clinical implications could be influenced by these limitations. For instance, the lack of inter-observer variability may impact the reproducibility of these results in broader clinical settings. Fourth, the sample size and geographic focus may limit the generalizability of the results. Future research should aim to include larger, more diverse populations to validate these findings and explore advanced imaging techniques to capture a more comprehensive classification of impacted teeth. Lastly, employing multi-center trials and advanced statistical techniques may help better elucidate the relationship between genetic factors, such as BG, and impact patterns.

Conclusion

This study provides novel insights into the relationship between blood groups and impacted third molars, particularly with respect to the Pell and Gregory classification. The findings highlight the possible clinical significance of incorporating genetic and demographic factors into dental practice. Future research should investigate the underlying biological mechanisms that drive these associations and assess their implications in larger, more diverse cohorts.

Conflict of interest

The authors declare no conflict of interest.

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