Open Access

Original Article

Comparison of Maxillary First Molar Rotation Among Class I, Class II, and Class III Malocclusions: A Cross-Sectional Comparative Study

Abdul Ahad, Abdullah Jan, Kashif Iqbal, Noor Javed, Maryam Naseem*, Amer Ali

Department of Orthodontics, Armed Forces Institute of Dentistry, Rawalpindi/National University of Medical Sciences (NUMS) Pakistan, *Department of Dentistry, Foundation University Rawalpindi Pakistan

ABSTRACT

Objective: To compare the rotation of the maxillary permanent first molar among patients with Class I, Class II, and Class III malocclusions.

Study Design: Cross-sectional Comparative Study.

Place and Duration of Study: Armed Forces Institute of Dentistry, Rawalpindi, Pakistan, from Jan to Dec 2025.

Methodology: This study used a non-probability consecutive sampling technique on 90 cases. Inclusion criteria were the availability of dental casts, cephalograms, and profile photographs, while participants with missing or restored upper first molars, posterior crossbite, excessive wear, or incomplete records were excluded. Age and gender were recorded, and permanent maxillary first molar rotation was measured on dental casts. One-way ANOVA and chi-square tests were used to compare the rotation of permanent maxillary first molars among classes.

Results: The mean age was 21.1±5.9 years. There were 54 females (60%) and 36 males (40%). Participants were equally distributed across skeletal classes, with 30 individuals (33.3%) in each of Classes I, II, and III. The mean permanent maxillary molar rotation differed significantly among classes, with Class II showing the highest rotation (78.7±5.7) compared with Class III (73.4±9.2) and Class I (71.6±3.8) (p<0.001). When categorized as rotation >73°, the proportion of rotated molars was highest in Class II (73%), followed by Class III (47%) and Class I (27%) (p=0.0013).

Conclusion: Permanent Maxillary first molar rotation is significantly associated with sagittal skeletal pattern in untreated young adults. The most pronounced rotation occurs in individuals with skeletal Class II relationships, with a higher prevalence of rotated molars than in Class I or Class III.

Keywords: Maxillary First Molar, Molar Rotation, Skeletal Malocclusion, Class II Malocclusion, Sagittal Skeletal Pattern.

How to Cite This Article: *Ahad A, Jan A, Iqbal K, Javed N, Naseem M, Ali A. Comparison of Maxillary First Molar Rotation Among Class I, Class II, and Class III Malocclusions: A Cross-Sectional Comparative Study. Pak Armed Forces Med J 2026; 76(Suppl-8): S1228-S1232.*

DOI: https://doi.org/10.51253/pafmj.v76iSUPPL-8.14291

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (https://creativecommons.org/licenses/by-nc/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

The maxillary first molar plays a significant role in the development, diagnosis, and classification of malocclusion.[1] Angle considered its position a significant landmark to determine the sagittal jaw relationship and classified it as a key position.[2] In addition to its anteroposterior position, the maxillary first molar is also clinically significant for its relationship to the arch, occlusion, and cusp/fossa relationships.[3,4] Maxillary 1st molar Mesiopalatal rotation will decrease the arch perimeter and possibly exacerbate sagittal discrepancies.[5] It can worsen class II relationships, but may help with intercuspation and provide 1-2 mm of additional arch length on each side.[6]

There are several different patterns of molar rotations in malocclusions. The maxillary first molars are often mesially rotated in Class II malocclusion, which affects the occlusion and interdigitation.[7] In Class III cases, mesiopalatal or distal-out rotation of molars may occur as a compensatory movement, but is not necessarily associated with a skeletal imbalance seen in Class I cases.[8] Distal-out or mesiopalatal rotation of the molars, although small, can affect arch coordination and functional occlusion.[9,10]

Understanding maxillary first molar rotation in Class I, II, and III malocclusions is important for orthodontic diagnosis and treatment planning. Correction of molar rotation can improve arch development, occlusal stability, and molar and canine relationships. Although clinically important, molar rotation is often overlooked in routine analysis. Evaluating rotational patterns among different malocclusion classes may help in treatment planning and orthodontic mechanics. The objective of this study was to compare the rotation of the maxillary first molar among patients with Class I, Class II, and Class III malocclusions.

Correspondence: Dr Abdul Ahad, Department of Orthodontics, Armed Forces Institute of Dentistry, Rawalpindi Pakistan

Received: 17 Feb 2026; revision received: 01 Jun 2026; accepted: 02 Jun 2026

METHODOLOGY

This comparative cross-sectional study was conducted at the Armed Forces Institute of Dentistry, Rawalpindi, Pakistan, from Jan to Dec 2025 using a non-probability consecutive sampling technique. Ethical approval was obtained from the hospital's ethical committee. Informed consent was obtained from all participants after an in-depth explanation of the study.

The sample size was calculated using OpenEpi with the independent mean difference formula. Input parameters included a 95% confidence interval, 80% power, and equal group sizes (ratio 1:1). For comparing two means (rotation in Class I: 71.23±3.83; rotation in Class II: 78.95±6.197), the calculated sample size was 7 per group, giving a total of 14 participants. However, to satisfy the normality assumption, we included a total of 90 participants, with 30 cases per group (30 each for Class I, II, and III).

Inclusion Criteria: Pakistani population, aged between 12 and 30 years, of both genders, with dental casts, cephalograms, and profile photographs that allowed classification into one of the following groups: skeletal Class I, II, or III were included in the study.

Exclusion Criteria: Patients with missing upper first permanent molars, posterior crossbite, upper first molars with excessive wear or prosthetic reconstruction, or incomplete records were excluded from the study.

Age and gender were recorded from patients' files. The rotation of maxillary first molars was measured with photocopies of upper dental casts. A graphite pencil was used to mark the mesio-palatal and disto-buccal cusps of every molar, with a 0.5 mm graphite pencil. The photocopies were rotated, and the angle between the line joining the mesio-palatal and disto-buccal cusps of the molar (Ricketts line) and a reference line run along the palatine raphe was determined. The measurements were done using a protractor (Trident/ Desetec, Itapui, SP, Brazil), and intermediate readings were taken to the closest 0.5o. Marking and measurement were done by an examiner who was previously trained. Patients were classified into skeletal Class I, II, and III based on ANB values, where Class I had an ANB of 2–4, Class II had an ANB greater than 4, and Class III had an ANB less than 1. Only the right side was considered when molar rotation was present on both sides.

In order to determine the accuracy of the photocopies, 20 randomly selected plaster models were directly measured with a 2 mm glass plate to replicate the same angle, and the values were compared to the values on the photocopies; a paired t-test did not reveal any statistically significant difference (P<0.05). Intraclass correlation coefficient and the Dahlberg formula were applied to assess the evaluations of reproducibility and random error by repeating the measurements 1 week later, respectively.

Data analysis was done in R software version 4.3.3. Data were described in terms of mean and standard deviation for continuous variables and frequency with percentages for categorical variables. Normality was assessed using the Shapiro-Wilk test. One-way ANOVA was run to compare rotation in degrees among the three classes, and chi-square was used to compare the presence of rotation. Analyses were stratified by gender. P≤0.05 was considered the significant threshold.

RESULTS

Of the total 90 participants, the mean age was 21.1±5.9 years. There were 54 females (60%) and 36 males (40%). Participants were equally distributed across skeletal classes, with 30 individuals (33.3%) in each class I, II, and III. (Table-I).

Table-I: Demographics and skeletal classes pattern of the Participants (n=90)

Variable	Characteristic	Mean±SD / n(%)
Age in years	Mean ± SD	21.14±5.91
Gender	Female	54 (60.00%)
	Male	36 (40.00%)
Class	I	30 (33.33%)
	II	30 (33.33%)
	III	33.33%)

The mean molar rotation was significantly different among classes, with class II having the highest rotation (78.7±5.7) as compared with class III (73.4±9.2) and class I (71.6±3.8) (p<0.001). When categorized as rotation >73°, the proportion of rotated molars was highest in class II (73%), followed by class III (47%) and class I (27%) (p=0.0013). (Table-II).

Table-II: Comparison of Rotation in the Upper first Molar Among Three Skeletal Classes (n=90)

Variable	Characteristic	Skeletal class			p-value
		I (n=30)	II (n=30)	III (n=30)	
Molar Rotation in degrees	Mean ±SD	71.55±3.82	78.74±5.72	73.44±9.22	<0.001
Rotation >73 degrees, n (%)	No Rotation	22 (73%)	8 (27%)	16 (53%)	0.0013
	Rotation	8 (27%)	22 (73%)	14 (47%)	

**p-values calculated using: ANOVA, Chi-square test*

Table-III shows that the differences between class I vs II and class III vs II were significant, but not between class I vs III. Table-IV shows upper first molar rotation across skeletal classes, stratified by gender. In males (n=36), mean rotation was slightly higher in class II (77.3±5.9) and class III (74.8±8.8) compared with class I (71.6±2.9), but these differences were not statistically significant (p=0.102). The proportion of molars rotated >73° also did not differ significantly among male participants (p=0.060). In females (n=54), rotation was significantly greater in class II (79.7±5.6) than in class I (71.5±4.4) or class III (72.5±9.6) (p=0.0014). Correspondingly, a higher proportion of class II females exhibited rotation >73° (83%) compared with class I (33%) and class III (39%) (p=0.004).

Table-III: Comparison of Maxillary First Molar Rotation Among Skeletal Class I, II, and III Subjects (n=90)

Parameter	Class I (n=30) Mean±SD	Class II (n=30) Mean±SD	Class III (n=30) Mean±SD	ANOVA *p*-Value	Class I vs Class II	Class II vs Class III	Class I vs Class III
Molar rotation (°)	71.55±3.82	78.74±5.72	73.44±9.22	<0.001	<0.001	0.0076	0.510

Table-III: Comparison of Rotation in the Upper first Molar Among three Skeletal Classes Stratified by Gender(n=90)

Gender	Variable	Characteristic	Skeletal class			*p*-value
			I	II	III	
Male (n=36)	Molar Rotation in degrees	Mean±SD	71.63 ±2.90	77.34±5.92	74.83±8.80	0.102
	Rotation >73 degrees, n (%)	No rotation	10(83%)	5(42%)	5 (42%)	0.060
		Rotation	2(17%)	7(58%)	7 (58%)	
Female (n=54)	Molar Rotation in degrees	Mean±SD	71.49 ±4.41	79.67 ±5.55	72.52±9.63	0.001
	Rotation >73 degrees, n (%)	No Rotation	12 (67%)	3 (17%)	11 (61%)	0.004
		Rotation	6 (33%)	15 (83%)	7 (39%)	

**p-values calculated using: ANOVA, Chi-square test*

DISCUSSION

Our study found that there is a significant association between sagittal skeletal pattern and rotation of the upper first molar in young adults who have not received any treatment. The highest molar rotations were observed in participants with a skeletal Class II relationship, with a higher number of rotated molars than in Class II, 1 and III. These results were persistent as molar rotation was classified (e.g., rotated vs. non-rotated) and gender stratified analysis proved that such an association was found in females especially. There were similar results in males, but the differences between skeletal classes were statistically insignificant.

From a biomechanical and developmental perspective, rotation of the upper first molar is an expression of the interaction of arch shape, eruption pattern, and function in the upper arch. The mesiopalatal inclination of the upper first molar - which is the most common direction of rotation - increases the effective crown width in the arch at the expense of available arch length and commonly worsens sagittal maladaptation.[11] This rotated form can be considered as a factor as well as a cause of occlusal imbalance in Class II patterns: with the maxillary arch developing with transverse deficiency or crowding, the first molar can be able to adapt through rotation to meet the mesial drift and eruption forces, which can also result in deepening the Class 2 molar relationship and hinder optimal intercuspation.[12] This positional differentiation also makes the space in the arch larger, affecting crowding and making space management and molar repositioning orthodontic mechanisms difficult. Clinically, it is therefore important to identify this rotation before treatment because molar derotation tends to produce a better arch perimeter and better sagittal relationships, which simplifies the treatment as reported by Lione *et al*.[5]

The differences in rotation of the upper first molar by skeletal classes in males were significant.[2] This sexual dimorphism can be attributed to differences in arch size and maturation time between the sexes. Females usually have narrower arch widths and may have varying maturation and eruption timelines, thus increasing the effects of skeletal pattern on molar position. This has been explained by Subramanian *et al*.[13]

Our results are in line with orthodontic literature that emphasizes the high prevalence of upper molar rotation - particularly mesiolingual rotation - as a manifestation of Class II malocclusions. Maharjan *et al*., reported that the prevalence of mesial rotation is high in Class II cases, and this rotational inclination has been attributed to transverse deficiencies and anteroposterior dental discrepancies.[14] Mesio palatal rotation in a huge proportion of dental Class II patients, and Shaheen *et al*., highlighted this as existing in 83-95% of such cases, showing that rotation is not just an incidental observation but a regular trait of Class II occlusal morphology.[15] Parthiban *et al*., systematic review also found that Class II malocclusion is associated with more upper first molar rotation than Class I or Class III, although the extent and frequency vary depending on measurement methods and sample characteristics.[3]

Quinzi *et al*., investigated the association between molar rotation and the severity of Class II

malocclusion and reported a positive correlation, with greater mesiolingual rotation associated with more pronounced anteroposterior discrepancies in Class II dental relationships.[16] This concept is also suggested by Alexander et al., that molar orientation is not merely an accompanying feature but may also contribute to the functional severity of the malocclusion.[17]

Investigations done by Ugolin *et al*., have demonstrated that, on the whole, the patterns of rotation of the molar are not very far apart among various skeletal groups. Nevertheless, dental Class II patients have the strongest and most common rotations, whereas skeletal Class II and III cases exhibit moderate and similar rotations.[18] These findings confirm our results, as it is evident that molar rotation is most evident when dental and skeletal discrepancies exist.

It is necessary to know how the presence of molar rotation can be used in planning a treatment based on the skeletal pattern.[19] Molar rotation can be corrected early to provide more space in the arch, a better fit of the teeth, and make sagittal correction more effective.[20] It may also affect the selection of treatment methods, e.g., arch expansion or molar derotation appliances, particularly in the Class 2 cases, where the space and molar derotation plane management are decisive factors.

LIMITATIONS OF STUDY

The single-center design, non-probability consecutive sampling, and relatively small sample size, which may limit generalizability. Additionally, the cross-sectional nature of the study precludes causal inference regarding the association between maxillary first molar rotation and sagittal malocclusion. Populations' habits, diet, and gender preferences regarding maxillary molar rotations are recommended to be explored for an in-depth understanding of these rotation patterns.

CONCLUSION

Upper first molar rotation has a significant association with sagittal skeletal pattern in untreated young adults. The most pronounced rotations are with skeletal Class II relationships, with more rotated molars than in Class I or Class III. This pattern was significant in females, while in males, the differences between skeletal classes were not statistically significant.

Conflict of Interest: None.

Discolure:

Funding Source: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

AA & AJ: Data acquisition, data analysis, critical review, approval of the final version to be published.

KI & NJ: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

MN & AA: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

1. Saghiri M, Eid J, Tang C, Freag P. Factors influencing different types of malocclusion and arch form–A review. *J Stomatol Oral Maxillofac Surg* 2021; 122(2): 185-191. http://doi.org/10.1016/j.jormas.2020.07.002
2. Alghamdi M, Tashkandi N. Relationship between Dental Arch Parameters and Mandibular Plane Angle. *J Adv Med Dent Sci Res* 2022; 10(5): 105-122. http://doi.org/10.1177/00220345710500043801
3. Parthiban R, Kailasam V, Venkatasamy NS. Rotations of teeth: a systematic review. *Front Oral Health* 2024; 5: 1484020. http://doi.org/10.3389/froh.2024.1484020
4. Murugan SM, Kailasam V, Rao GU, Krithika C, Kirthiga M, Aarthi J, et al. Changes in Andrews' fifth key of occlusion (interproximal contacts) before and after orthodontic treatment. *J Clin Pediatr Dent* 2024; 48(4): 86-98. http://doi.org/10.22514/jocpd.2024.082
5. Lione R, Paoloni V, De Razza FC, Pavoni C, Cozza P. Analysis of maxillary first molar derotation with Invisalign clear aligners in permanent dentition. *Life* 2022; 12(10): 1495. http://doi.org/10.3390/life12101495
6. Rakhshan V, Ghorbanyjavadpour F, Ashoori N. Buccolingual and Mesiodistal Dimensions of the Permanent Teeth, Their Diagnostic Value for Sex Identification, and Bolton Indices. Biomed Res Int. 2022; 2022: 8381436. https://doi.org/10.1155/2022/8381436
7. De Oliveira Viganó C, da Rocha VE, Junior LRM, Paranhos LR, Ramos AL. Rotation of the upper first molar in Class I, II, and III patients. *Eur J Dent* 2016; 10(1): 59-63. http://doi.org/10.4103/1305-7456.175696
8. Özden S, Cicek O. Analysis of the effect of maxillary transverse deficiencies on permanent maxillary first molar rotations using 3D digital models. BMC Oral Health 2025; 25(1): 879. https://doi.org/10.1186/s12903-025-06301-x
9. Hashemzadeh H, Soleimani M, Golbar M, Dehghani Soltani A, Mirmalek SP. Canine and molar movement, rotation, and tipping by NiTi coils versus elastomeric chains in first maxillary premolar extraction orthodontic adolescents: A randomized split-mouth study. Int Orthod 2022; 20(1): 100601. https://doi:10.1016/j.ortho.2021.11.002
10. Elfouly D, El-Harouni NM, Ismail HA, El-Bialy T, Ghoneima A. Tip, torque and rotation of maxillary molars during distalization using Invisalign: a CBCT study. BMC Oral Health 2024; 24(1): 797. https://doi.org/10.1186/s12903-024-04529-7

11. Zaoui F, ELHONSALI Y, Mohimd HB, Halimi A. Maxillary molars in class II, derotate or distalize: A systematic review. *Al-Rafidain Dent J* 2023; 23(1): 53-64. http://doi.org/10.33899/rdenj.2023.137944.1191
12. Serafin M, Fastuca R, Castellani E, Caprioglio A. Occlusal plane changes after molar distalization with a pendulum appliance in growing patients with Class II malocclusion: a retrospective cephalometric study. *Turk J Orthod* 2021; 34(1): 10. http://doi.org/10.5152/turkjorthod.2021.20050
13. Subramanian M, Rajasekaran U, Prabu N, Deepak A, Keerthana V, Priyanka K, et al. Assessment of Dental Arch Width in Individuals With Various Growth Patterns: A Cross-Sectional Study. *Cureus* 2025; 17(11): e96312. http://doi.org/10.7759/cureus.96312
14. Maharjan S, Rajbhandari A, Pradhan R, Bajracharya M, Pant BD. Assessment of maxillary first molars rotation in class II malocclusion cases: A cross-sectional study. *Orthod J Nepal* 2022; 12(2): 15-18. https://doi.org/10.3126/ojn.v12i2.49771
15. Shaheen A, Momina AU, Shahnawaz A, Amin U, Farooq A, Ibrar A. Comparison of maxillary first molar rotation in hyper- and hypodivergent patients. *Pak Orthod J* 2020; 12(1): 31-35. https://poj.org.pk/index.php/poj/article/view/282
16. Quinzi V, Tecco S, Nota A, Caggiati E, Mummolo S, Marzo G. Mesial rotation of the upper first molar: association with anterior dental crowding in mixed and permanent dentition. Appl Sci 2020; 10(15): 5301. https://doi.org/10.3390/app10155301
17. Alexander L, Arun V. Influence of maxillary first molar rotation on the severity of dental class II malocclusion: A cross-sectional study. *J Orthod Sci* 2023; 12(1):52. http://doi.org/10.4103/jos.jos_3_23
18. Ugolini A, Bruni A, Abate A, Maspero C, Silvestrini-Biavati F, Lanteri V. Upper arch expansion and spontaneous upper first molar distorotation with Ni–Ti leaf springs and rapid maxillary expander compared to clear aligners. *J Orofac Orthop* 2026; 31: 1-11. http://doi.org/10.1007/s00056-026-649-7
19. Zhou Y, Wang S, Xu L, Si J, Chen X. Implications of occlusal plane in diagnosis and treatment of malocclusion. Zhejiang Da Xue Xue Bao Yi Xue Ban 2023; 52(2): 237-242. https://doi.org/10.3724/zdxbyxb-2022-0694
20. Hu H, Lin W, Wu J, Xu H. Research on the correlation between the size of condyle and occlusion plane in skeletal Class II malocclusions. Clin Exp Dent Res 2022; 8(6): 1547-1554. https://doi.org/10.1002/cre2.672