Correlation of Mandibular Second Molar Impaction with Third Molar Size, Angulation, Developmental Stage, and Bud Position

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Abstract

Objective: The present study assessed the association of size, axial angulation, developmental stage and bud position of the mandibular third molar with the second molar impaction in patients with mandibular second molar impaction.

Methods: In this descriptive-analytical study (Case-Control Design), dental records of 5,420 patients in the age range of 12-15 years who underwent orthodontic treatment were assessed out of which 20 patients (14 females and 6 males) with lower second molar impaction were studied. Twenty control patients with erupted second molars were selected from the same centers and matched with the case group. Total sample size was 40 (Case and Control) and had normal distribution for the determined measurements. Third molar axial angulation towards the second molar, first molar and mandibular base, mesiodistal width of 3rd molar /2nd molar ratio, Nolla developmental stage and third molar bud position were measured and calculated in patients with impacted and erupted second molars and analyzed using student t and chi-square tests.

Results: The mean degree of third molar angulation towards the second molar, first molar and mandibular base was 30.20, 53.6, and 51.3 degrees in cases and 21.4, 34.65 and 45.15 degrees in controls, respectively. Significant differences were found between the two groups in terms of third molar angulation towards the second molar (30.2 Vs 21.4 degrees $p<0.047$), and first molar (53.6 Vs 34.65 degrees $p<0.0001$); while no differences were found between the two groups in terms of third molar angulation towards the mandibular base (51.3 Vs 45.15 degrees). The mean mesiodistal width of third molar/ second molar ratio was 0.99 in cases and 0.95 in controls with no significant difference. Nolla developmental stage and position of the marginal ridge of the third molar bud towards the second molar showed no definite relation with second molar impaction.

Conclusion: It seems that angulation of third molar to the second and first molars is a major contributing factor to increase the risk of second molar impaction. Third molars size, developmental stages, and bud positions, do not show a significant relation to the second molar impaction.

Key words: Mandibular second molar, Impaction, Eruption, Third molar

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Introduction:

Development of the tooth in the alveolar ridge results in eruption of the teeth into the oral cavity. Before appearing in the oral cavity, developing teeth go through several stages of movement within the developing ridge after which they reach to their optimal position in the oral cavity (1). Eruption of the dental bud is usually faster during the first months of formation and slows down following the appearance of half the crown into the oral cavity. This trend continues until the tooth reaches the occlusal plane (2). In some circumstances, there are some teeth that cannot naturally erupt and remain impacted in the bone. Such teeth are categorized into the following groups of impacted teeth, malposed teeth (abnormally positioned) and embedded teeth (tooth lying horizontally in the bone)(3-6).

In contrast to the third molar, mandibular 2nd molar impaction is a rare phenomenon with an estimated prevalence of 0.21-0.3% (3 in 1000 cases) and seems to be correlated with insufficient development of the jaw (7). Second molar impaction can cause numerous problems for patients in terms of esthetics, function of the muscles of mastication, and stability of the dental arch (7). Second molar impaction mostly occurs in the mandible unilaterally and its prevalence is slightly greater among women (8). Causes of second molar impaction include decreased length of the dental arch, delayed eruption of second premolars, premature extraction of deciduous molars, ankylosed deciduous molars, presence of a dentigerous cyst, lack of space in posterior mandibular region (3rd molar area), and odontomas (8). In addition, in case of 2nd molar impaction or its disturbed eruption, root resorption, caries and periodontal destruction of the first molar are among the common sequelae (8).

The best time for treatment of patients with 2nd molar impaction is in the age range of 10-17 years when the roots of the 3rd molar tooth have yet to form. At this time roots of the 2nd molar are one-third to half their full length with open apices (9).

Generally, the process of 2nd molar eruption starts with the onset of its calcification at the age of 2. The crown formation is completed at the age of 7 and the tooth erupts at the age of 12. Roots are fully developed by the age of 16. Second molars play a significant role in mastication. Therefore, it is especially important to find out about the factors that may derange or delay its eruption and how to prevent them. The role of third molar in this respect has been discussed extensively in the literature. Characteristics of the third molar bud can greatly influence the eruption of the 2nd molar. Time of formation and eruption of the mandibular 3rd molar varies greatly but in general, calcification of the wisdom tooth starts at the age of 9, its crown formation completes at the age of 14 and it usually erupts at the age of 20. Thus, formation of the crown of the 3rd molar is somewhat simultaneous with the eruption of the 2nd molar and there is a possibility of 2nd molar impaction as the result of the position of the 3rd molar bud (9).

Varpio and Wellfelt (1988) in their study demonstrated that lower second molar impaction was more prevalent among males with the mean age of 15 years. They noted that in 95% of cases, a 3rd molar was found adjacent to the affected 2nd molar and most cases had tooth space deficiency. They reported the prevalence of this condition to be 1.5 per 1,000 individuals. They also showed that mesio-angular and disto-angular impactions occurred mostly as the result of lack of space whereas vertical impactions had additional influential factors (10).

Kavadia and Antoniades in their study in 2003 reported that early extraction of the mandibular 3rd molar facilitates the eruption of the 2nd molar especially in cases where other factors such as inadequate mandibular growth, use of orthodontic appliances, altered path of eruption, lack of space in the posterior mandibular region and a larger than normal 2nd molar exist (11).

This study aimed at determining Correlation of Second Molar Impaction with Third Molar Size, Angulation, Developmental Stage, and Bud Position.

Methods:

This descriptive analytical Case-Control study was conducted on patients presenting to the orthodontic department of Tehran and Shahid Beheshti Universities of Medical Sciences, School of Dentistry and a private office from 1991-2006. A total of 5,420 dental records were consecutively reviewed. Patients who had both clinical and radiographic evidence of mandibular 2^{nd} molar impaction were selected. Mandibular 2^{nd} molar was considered impacted when it had two thirds of its roots developed but was still unerupted when its corresponding maxillary second molar was fully erupted. Our selected cases had no dentofacial deformity or facial asymmetry and had Class I occlusion. Among patients with Class II or Class III malocclusion, only cases due to maxillary protrusion or retrusion and mandibular cephalometric angles within normal range were selected. Considering the age of eruption of the mandibular second molar (11-12 years), only cases in the age range of 12-15 years old were selected.

A total of 20 dental records met the criteria (14 girls and 6 boys) and entered the study. The control group comprised 20 cases with fully erupted mandibular 2^{nd} molars selected from the dental records of patients in the age range of 12-15 yrs. Cases and controls were matched in terms of confounding factors i.e. age,gender,and right or left sides.

Lateral cephalometric analysis was used to evaluate general dentofacial status and mandibular angles of patients in order to make sure they possess all the inclusion criteria. Orthopantomogram was taken to ensure cases meet the main study criteria.

First, axial angulation of the mandibular 3^{rd} molar bud towards the mandibular 2^{nd} molar was measured. In order to determine the longitudinal axis of the mandibular 2^{nd} molar, Evans method (1988) was used (12). In this technique, in order to find the longitudinal axis of the mandibular 2^{nd} molar a tangent line is drawn connecting the tip of the cusps and a second line is drawn perpendicularly to the first line passing through the furcation area. This second line indicates the longitudinal axis of the tooth.

Since the roots of the mandibular 3^{rd} molar had yet to develop, a tangential line was drawn connecting the tip of the cusps and perpendicular bisector of this line was considered as the longitudinal axis of the tooth. Longitudinal axis of the mandibular first molar was also drawn using the same method used for the 2^{nd} molar. Finally, angulation of the 3^{rd} molar axis to the base of mandible was measured. Base of mandible was defined as a line connecting the Gonion and Menton. Afterwards, the ratio of the size of third molar to 2^{nd} molar was calculated. In order to do so, first the mesiodistal width of the teeth was measured and then the ratio was calculated. This way the adverse effect of radiographic magnification observed in panoramic radiographies which could cause a major error in the results was obviated. In the next phase, developmental stage of the 3^{rd} molar bud was evaluated using Nolla classification for teeth developmental stage and the developmental stage of the lower 3^{rd} and 2^{nd} molars were then compared.

Ten stages of Nolla classification are as follows:

1. Formation of dental follicle
2. Primary calcification
3. One third of the crown is formed
4. Two third of the crown is formed
5. Formation of crown is almost complete
6. The crown is completely formed
7. One third of the root is formed
8. Two third of the root is formed
9. Root formation is almost complete
10. Apex closes

Evaluation of these criteria is important for researchers because this way they can assess the effect of premature formation and development of 3^{rd} molar bud on 2^{nd} molar impaction.

In order to evaluate the position of the 3^{rd} molar bud, the position of its mesial marginal ridge was studied and categorized into one of the following 4 groups:

1- At the level of the distal marginal ridge of the lower 2^{nd} molar

2- At the level of the distal height of contour (HOC) of the lower 2^{nd} molar

3- At the level of the CEJ of the lower 2nd molar
4- Lower than the CEJ of the mandibular 2nd molar

All angular and linear measurements were made using Corel Draw version 12 software. All measurements were made twice by 2 trained senior dental students. The mean of these measurements was used for statistical analysis. Considering the normal distribution of data, student t test was used for comparisons. Qualitative variables were evaluated in 2 groups of cases and controls using chi square test.

Results:

Relative frequency distribution of controls according to their referring centers were 10 (50.0%), 2 (10.0%), and 8 (40.0%), respectively. The mean age of cases was 157.90 months with a standard deviation (SD) of 9.51 months; whereas, the mean age of controls was 159.05 months with a SD of 7.63 months. Student t test was used to compare the mean age and SD of both groups but failed to find any significant difference in this respect ($p>0.68$). There were 8 (40%) males and 12 (60%) females in the case group and 8 males (40%) and 12 females (60%) comprised the control group. A total of 16 males (40%) and 24 females (60%) were evaluated in both groups.

Among cases, 11 (55%) had right lower impaction and the remaining 9 (45%) had left lower impaction. Similar condition were detected among controls. Axial angulation of the lower 3rd molar towards the 2nd molar in cases with 2nd molar impaction was 30.2 (16.86) degrees (mean (SD)). In controls (with erupted 2nd molar) this value was 21.40 (8.73) degrees. According to t student test results, the 2 groups had a significant difference in terms of axial angulation of the 3rd molar towards the 2nd molar. The mean difference between the 2 groups was 8.80 degrees ($p<0.047$) (Diagram 1).

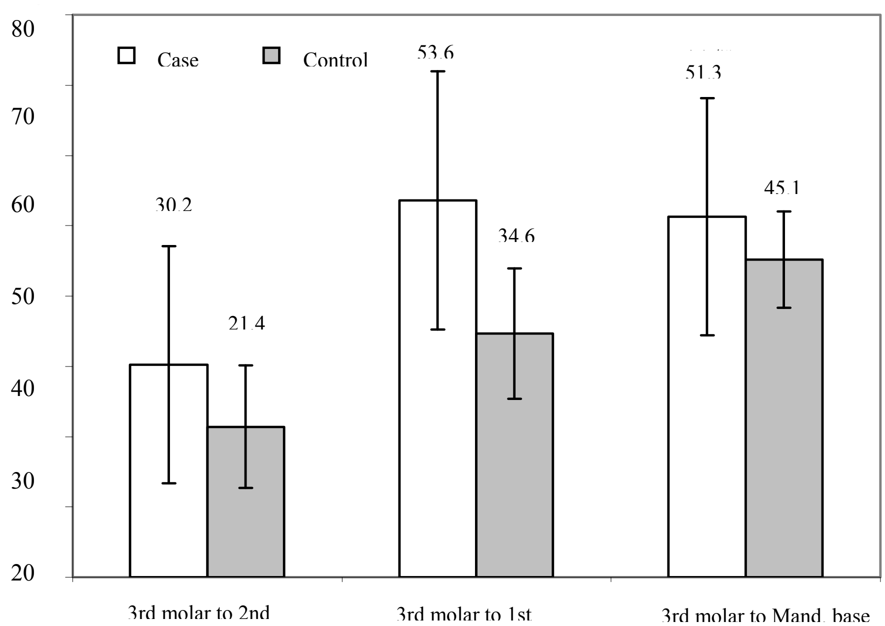

Diagram 1- Angulation of third molar relative to mandibular base, first and second mandibular molars

Also, axial angulation of the 3rd molar towards the first molar in cases suffering from 2nd molar impaction was 53.60 (18.35) degrees. This valuein controls with erupted 2nd molar was

34.65 (9.27) degrees. Statistically significant differences were found in this respect between the 2 groups using student t test. The mean difference in axial angulation of 3rd molar towards the first molar in the 2 groups was 18.95 degrees ($p<0.0001$). In other words, axial angulation of the lower 3rd molar towards the first molar was statistically greater in the case group (with 2nd molar impaction) compared to controls (with erupted 2nd molar).

The mean and SD of the axial angulation of the lower 3rd molar towards the base of mandible was 51.30 (16.87) degrees in cases and 45.15 (6.84) degrees in controls. Student t test could not find a statistically significant difference in this respect between the 2 groups; the mean difference between the 2 groups was 6.15 degrees ($p>0.14$).

The ratio of the mesiodistal width of the mandibular 3rd molar to mandibular 2nd molar was 0.98 (0.11) in cases with 2nd molar impaction and 0.951 (0.05) in controls with erupted 2nd molar. T student test showed no significant difference in this respect between the 2 groups ($p>0.13$). In other words, this ratio is almost the same in cases with impacted or erupted 2nd molars. Cases in whom mandibular 3rd molar was in Nolla developmental stages 3 and 4 were put in one group and those in the stages 5 and 8 were placed in another and compared among cases and controls. In the case group, 15 patients (75.0%) were in the developmental stages 3 and 4 and 5 patients (25.0%) were in stages 5 and 8. These measurements were 16 (80.0%) and 4 (20.0%) in controls, respectively. Chi square test showed no significant difference in this respect ($p>0.71$). It means that cases with an impacted 2nd molar had no significant difference compared to those with an erupted 2nd molar in terms of Nolla developmental stage of their 3rd molar.

Similar grouping was performed for the mandibular 2nd molar in a way that cases with mandibular 2nd molar in the developmental stages 6 and 7 were placed in one and those in stages 8 and 9 were put in another group and compared using chi square test. Among cases, 13 (65.0%) were in stages 6 and 7 and 7 cases (35.0%) were in stages 8 and 9. Among controls (with erupted 2nd molar) 5(25.0%) were in stages 6 and 7 and 15 (75.0%) were in stages 8 and 9. A significant difference was found in this respect between the 2 groups using chi square test ($p<0.01$). The 2 groups were in different Nolla stages and a higher percentage of cases with impacted lower 2nd molar were in a lower developmental stage.

The position of the mesial marginal ridge of the 3rd molar bud towards the 2nd molar was divided into 4 categories and evaluated in the 2 groups of cases and controls. Position of the mesial marginal ridge of the 3rd molar bud in the case group was at the level of the distal marginal ridge of the 2nd molar in 2 cases (10.0%), at the HOC of the 2nd molar in 5 (25.0%), at the CEJ of the 2nd molar in 9 (45.0%) and was lower than the CEJ of the 2nd molar in 4 (20.0%). In controls, position of the mesial marginal ridge of the 3rd molar bud was at the level of the distal marginal ridge of the 2nd molar in 2 (10.0%), at the HOC of the 2nd molar in 7 (35%), at the CEJ level in 5 (25.0%), and lower than the CEJ in 6 (30.0%). Position of the mesial marginal ridge of the 3rd molar bud was evaluated and compared in the 2 groups using chi square test. However, no significant difference was detected between cases and controls ($p>0.59$). In other terms, position of the mesial marginal ridge of the mandibular 3rd molar bud was almost similar in cases and control.

Discussion:

Ectopic eruption or impaction of teeth is an important clinical problem encountered by dentists and challenges both the patient and the orthodontist. Management of such conditions requires combined expertise of a number of clinicians (13). Our study showed that the mean axial angulation of the mandibular 3rd molar towards the 2nd molar was 30.2 degrees in cases and 21.4 degrees in controls. This difference between the 2 groups was statistically significant ($p<0.04$). Also, the mean axial angulation of the 3rd molar towards the first molar was 53.6 degrees in cases with an impacted 2nd molar while this rate was 34.65 degrees in those with erupted 2nd molar. This difference was also statistically significant ($p<0.0001$). It means that axial angulation of the 3rd molar towards the first molar was significantly greater in cases with an impacted 2nd molar compared to controls with an erupted 2nd molar. The mean axial angulation of the mandibular 3rd molar towards the base of mandible was 51.3 degrees in cases and 45.15 degrees in controls. No significant difference was detected in this regard ($p>0.14$). Axial angulation of the mandibular 3rd molar towards the base of mandible was greater in cases with lower 2nd molar impaction compared to controls with an erupted 2nd molar. However, since the standard deviation of the values in the case group was considerably high, this difference was not considered statistically significant. The authors believe that the aforementioned compensation between molar inclination and mandibular base shows that morphological remodeling has a crucial role in eruption of teeth i.e. mandibular base is tilted in accordance to angulated third molar. In case of normal development of mandibular base from stand point of morphology and architecture, molar teeth can erupt without being impacted or creating a physical barrier for one another.

Erdem in 1998 investigated the differences between 2 groups of patients with either erupted or impacted mandibular third molars and measured the angle between the occlusal surface of the 3rd molar and Frankfurt plane (mandibular arch angle). He concluded that this angle decreased during the course of orthodontic treatment in both cases and controls (14). This decrease was greater in controls with an erupted mandibular 3rd molar. However, it was not statistically significant. He also reported that erupted 3rd molars were more upright compared to impacted ones. This finding was in accord with those of Richardson (15). They found that molars with smaller angulation erupt sooner than those with a wider angle (15).

No statistically significant difference was detected when comparing the ratio of mesiodistal width of the lower third molar to 2nd molar in cases with lower 2nd molar impaction (mean=0.98)and those with an erupted 2nd molar (mean= 0.95).

Nolla classification was used to compare the developmental stage of the lower 3rd and 2nd molars at the time of taking the radiographs. Evaluation of the developmental stage of the lower 3rd molar in both groups revealed no significant difference in this respect. However, developmental stage of the lower 2nd molar was statistically different in the 2 groups. A larger number of cases were in lower developmental stages compared to controls. Lack of difference in developmental stage of the lower 3rd molars in cases and controls indicates that early formation and development of the 3rd molar bud has no significant effect on the impaction of lower 2nd molar.

Position of the mesial marginal ridge of the lower 3rd molar towards the 2nd molar was also evaluated to find if it has any effect on 2nd molar impaction. Results demonstrated that position of the mesial marginal ridge of the 3rd molar was almost similar in both groups and no significant difference was found in this respect. It was concluded that position of the mesial marginal ridge of the lower 3rd molar bud plays no role in impaction of lower 2nd molar. Evaluation of the results in our study was performed using panoramic radiography. Several studies (15, 16) have shown the accuracy and validity of rotational panoramic radiography in longitudinal and angular measurements of 2nd molar and 3rd molar areas. Olive and Basford (1981) demonstrated better validity and reliability of panoramic radiography in 3D measuring of the 3rd molars compared to lateral cephalogram and bite wing radiographies (17). However, measurement of the buccolingual aspect of the 3rd molar or quantitative calculation of degree of rotation of molars cannot be performed using panoramic radiography. In the present study, by measuring the mesiodistal width of the understudy teeth, the adverse magnification effect of panoramic radiography as possible bias was obviated. According to a study by Habets and colleagues in 1987, when taking a panoramic radiography the position of patient's head is altered horizontally about 10 mm which may result in 6% error in determining the exact location of condylar space (18). Therefore, when interpreting the panoramic imaging findings, special attention should be paid to the asymmetry of the right and left side of the mandible. This asymmetry may occur as the result of the eccentric head position when taking the radiograph. Age of eruption of the second molar is limited and therefore, internal validity of such studies increases. In the present study, our cases were in the age range of 12-15 yrs and therefore a better internal validity is expected compared to similar studies (19). Also, all measurements were made by 2 trained senior dental students. They measured each variable twice and a mean of the 4-time measurements was used for final analysis which greatly increased the accuracy of this study.

Vedtofte and Andreasen (1999) evaluated the arrested eruption of lower second molars (M2inf) using profile radiographs and orthopantomograms in 19 patients aged 8-16 yrs when taking the radiographs. They demonstrated that craniofacial morphology and deviations in the dentition were associated with arrested eruption of lower second molar (20). Thus, it is important to evaluate craniofacial morphology and deviations of dentition for diagnosis and treatment planning in orthodontic treatment of cases with an impacted lower second molar. In another study on early extraction of the mandibular 3rd molar in case of eruption disturbances of the second molar, it was reported that early extraction of the lower third molar facilitates the eruption of the second molar especially in cases where evidence of crowding and lack of space exist in the posterior mandibular region (11). In such conditions, orthodontic treatment may aggravate eruption disturbances of the second molar.

E-space and its role in impaction of second mandibular molar have been discussed from different perspectives. Frank in 2000 suggests interventions as a treatment option for impacted teeth, and he means a second deciduous molar extraction and taking advantage of E-space to prevent M2 impaction (8). Nevertheless, authors believe that impactions and crowding are correlated and if one tries to relieve it through deciduous extraction, by omitting the functional matrix i.e. extracted tooth, crowding will be aggravated. Sonis and Ackerman in 2011 concluded that E-space preservation with a passive lingual arch increases (10 to 20 times more) the incidence of second mandibular molar impaction (21). Even so, it should be asked whether the thickness of molar bands has been examined, and band positioning and placements have been observed meticulously. On the other side of the spectrum, non-extraction orthodontics by space creating devices has been considered as a contributing element in producing the second molar impaction. Ferro *et al*. have reported unwanted effects in posterior arch following gaining space by means of lip bumper in the anterior arch (22). Lip bumper has an uprighting effect on the first molar that inhibits further eruption of second molar but second molar uprighting is possible by uprighting push spring appliance without the necessity of surgical assistance, bone removal, or splinting (23). In addition, uprighting of the impacted second mandibular molar has been conducted by orthodontic separating rings (24). Separating modules or ligated brass wires have had a role in deimpaction of molars traditionally but modern systems are mini screws as temporary anchorage systems. Lee *et al*. have tried to upright mandibular second molars with direct mini screw anchorage (25).

The retrospective overviews of treatment choice and outcome have been performed in large scale samples with arrested eruption, impaction, and retention of mandibular second molars (26-27). They found that the high percentages of unacceptable treatment outcome, 25.9% in group D (removal of third molar) and 23% in group E (removal of second molar). As the material was collected before (1985-2005) new advanced methods of surgical up righting and new methods of orthodontic up righting had been introduced, these percentages are expectedly lower today. Shinohara *et al*. suggest the germectomy approach to remove the impacted third molar for the eruption of the second molar through a vestibular incision. This incision offers an excellent bone exposure and exit route for the third molar without disturbing the gingiva attached architecture on the distal face of the first molar providing a good healing environment (28). Auto transplantation of an unerupted third molar tooth germ without its follicle(immediately after removal of an impacted mandibular second molar) has been conducted by Lai that suggests the dental follicle may function non-specifically with the crown and dental papilla of other tooth germs (29). And last but not least, dental caries is potential risk for retained or impacted second molar that should be taken into account even by most sophisticated tools (30).

Further studies are required to be performed on the problem of second molar impaction. Considering our current knowledge about facial growth, we can alert the orthodontists about the risk of impaction and evaluate eruption problems due to lack of space. The etiology of disturbed eruption of permanent teeth is still ambiguous and it seems that they may not be a simple local deviation and might be part of an extensive developmental disorder. In order to find a definite cause various studies on different aspects of this subject seem necessary.

Conclusion:

Axial angulation of the lower 3rd molar towards the second and first molars is greater in cases with an impacted lower 2nd molar compared to controls with an erupted second molar.

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Conflict of Interest: “None Declared”

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