Third Molars And Late Mandibular Incisor Crowding – A Review

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Abstract
The role of third molars in causing late mandibular incisor crowding is controversial. Various studies have been conducted to evaluate their relationship. The purpose of this article is to (a) review the studies regarding the mandibular third molars and late mandibular arch crowding (b) find out the cause and effect relationship between them (c) evaluate the justification of prophylactic extraction of third molars.

Keywords
Late mandibular incisor crowding, Third molars, Late mandibular growth, Anterior component of force, Randomized control trials, Prophylactic extraction of third molars.

Introduction
The role of the third molars in late lower incisor crowding is controversial and has been debated for more than a century. In a modern population, there is a strong tendency for crowding of mandibular incisor teeth to develop in the late teens and early twenties. Mild crowding of the incisors tends to develop in well aligned arches, or it increases if mild crowding is already present. Increased crowding of mandibular incisors takes place at about the time of third molar eruption. Although the mean age for third molar eruption is 20 years, mandibular anterior crowding continues well beyond the eruption of third molars in both untreated and treated individuals. Even in children who initially have generalized anterior spacing, the teeth become crowded as the decrease in arch length and intercanine width continues from adolescence to middle age. It is considered as a normal physiological process of maturation.

Robinson (1859) stated that irregularities frequently resulted from mesially directed third molar pressure. Broadbent (1941) was an advocate of the insignificant role played by third molars. As late as 1989, Richardson implicated the role of unerupted third molar in lower arch crowding. Several studies have been conducted to find out the association between the third molar and late mandibular incisor crowding and have varied findings and interpretations. Bishara and Andreasen (1983), Richardson (1989), Vasir NS and Robinson RJ (1991), Bishara (1999) have reviewed this subject.

In 1971, Laskin conducted a survey of more than 600 Orthodontists and 700 Oral surgeons and found that 65% were of the opinion that the third molar sometimes produce crowding of mandibular incisors. Two different views exist regarding the role of third molars in late lower incisor crowding.

1. Third molars should be removed on a prophylactic basis because they are frequently associated with future orthodontic and periodontal complications as well as other pathologic conditions.
2. There is no scientific evidence of a cause and effect relationship between the presence of third molars and orthodontic as well as periodontal problems.

Although there is a multifactor basis for late lower incisor crowding, the third molars are extracted on a prophylactic basis in most of the subjects to prevent late lower incisor crowding.
The purpose of this article is to review the evidence regarding the role of third molars in late lower incisor crowding, find out the cause and effect relationship between them, and to evaluate the justification of prophylactic extraction of third molars.

Changes in the mandibular arch with age

Crowding does not increase in a linear fashion with time. Most of the changes occur in late teens or early twenties. Late crowding is observed in both untreated and orthodontically treated subjects.

The changes in the mandibular arch in untreated subjects


Richardson (1982) 11 examined the changes in crowding during five years following eruption of all permanent teeth anterior to the third molars and found a tendency toward increased crowding.

Sinclair and Little (1983) 16 found that incisor irregularity increased from 13-20 years and females exhibited more incisor irregularity than males.

Bishara et al. (1989,94,96,97) 20,5,21,22 in the longitudinal studies of the changes in the dental arches and dentition between early childhood to adulthood, in adulthood, 25-45 years and 6weeks to 45 years and observed increased late incisor crowding in both the arches, more pronounced changes in mandibular anterior segment.

Richardson (1992) 24 studied lower arch crowding in the young adults between 18-21 years. She concluded that lower arch is stable, regardless of the third molar status or continued mandibular growth. In 1995, 15 she noted that lower incisor crowding increased significantly in the three years after second molar eruption. In 1998, 16 she examined lower incisor crowding in 46 untreated individuals in the third decade of life and found that the increase in crowding was very small and undetectable clinically. In a study of lower arch changes between 7 to 50 years (1999) 17 she noted that lower incisor crowding decreased between 7-12 years, increased between 12 years to 50 years. The maximum increase was between 13-18 years, little or no change in the third decade and a small increase occurred later in life.

Bondevik O (1998) 22 examined changes in crowding between 23-34 years and noticed that lower incisor crowding increased during that period.

Carter GA, McNamara et al. (1998) examined 82 subjects between late adolescence and fifth or sixth decade of life. They noted the increase in crowding was the same in males and females. It decreased in three percent males and seven percent females.

Buschang PH et al. (2003) 20 studied a random sample of 9044 individuals between 15-50 years of age, and found that crowding increased most during early adulthood and it was not associated with the third molar. Tiba et al (2004) 21 studied the sample of 27 individual with class I and normal occlusion. Mean age of the subjects was 21 years initially and 28 years at the end of the study. They observed increase in incisor irregularity.

The changes in lower incisors in orthodontically treated patients

Long-term studies have indicated that the severity of crowding increases during adolescence to adulthood in both normal, untreated subjects and also in orthodontically treated patients after retention is discontinued. The results of long-term longitudinal studies have shown continuing decrease in arch length, width and increase in incisor crowding with age. The problem is the inability to determine whether these changes occurred primarily as a result of the orthodontic therapy or a part of the normal development maturational process. Horowitz and Hixon (1969) 18 stated that orthodontic therapy might temporarily alter the course of these continuing physiological changes and possibly, for a time, even reverse them. However, following mechanotherapy and the period of retention restraint, the developmental maturation process resumes. Little and Bishara have noted in the long term studies that lower incisor crowding continues to increase even during adult stage.
Fastlicht in 1970 observed the changes in orthodontically treated subjects and found that crowding increased with age and third molars were not related to crowding.


Etiology of late lower arch crowding

The causes of late lower arch crowding in an untreated arch are:

1. Pressure from the posterior of arch
   a) Physiologic mesial drift
   b) The anterior component of forces of occlusion on mesially inclined teeth
   c) Mesial vectors of muscle contraction
   d) Presence of developing third molars

But these forces do not explain the increase in lower arch crowding in all subjects.

2. Late mandibular growth
3. Skeletal structures and complex growth patterns
4. Soft tissue maturation
5. Periodontal forces
6. Tooth structure/size
7. Occlusal factors
8. Connective tissue changes
9. Lack of attrition

Theories to account for late lower arch crowding

Three major theories have been put forward to explain this:

1. Lack of attrition in the modern population:

Raymond Begg, a pioneer Australian Orthodontist noted in his studies of Australian aborigines that malocclusion was uncommon and large amount of interproximal and occlusal attrition occurred. Because of this he advocated extraction of premolar teeth in modern population to provide the equivalent of attrition seen in aborigines. He was convinced that only anatomically correct occlusions resulted from attrition.

Proffit points out that Begg's theory does not explain the absence of late crowding in modern Australian aborigines who lack attrition of teeth due to modern diet. It has been observed in other population groups that late crowding may develop even after the premolars are extracted and arch length is reduced by modern orthodontic treatment. Thus this theory does not explain late crowding.

Corrucini RS in 1990 studied modern Australian aborigines who were among first generation lacking interproximal attrition due to modern diet. He concluded that small jaws rather than large teeth were the cause of tooth size arch length discrepancy.

Mockers O et al., 2004 investigated dental crowding from the copper age and examined the extent and pattern of wear. Crowding was estimated in 43 adult mandibles using Little's irregularity index. The remains were found at the archaeological site of Roaix, located in south of France. The sample used for the study was 43 intact mandibles. All the mandibles presented crowding with a majority of minimal and moderate irregularities, but in seven cases there were extreme irregularities and two canine impactions. The results are in contrast with the literature that crowding was rare in prehistoric population.

2. Late mandibular growth

Bjork's and Skiller's implant studies (1972, 1983) explain late crowding and its relationship to the growth pattern of the mandible. The rotation of the jaw influences the magnitude of eruption, direction of eruption and ultimate anteroposterior position of the incisors.

As a result of increased growth increments in the mandible than the maxilla because of cephalocaudal gradient of growth in late teens, the contact relationship of maxilla and mandibular incisors changes. At that time, one of these events take place,

1. Posterior displacement of the mandible accompanied by distortion of TMJ function and disc.
2. The upper incisors procline and spacing between these teeth appears.
3. The lower incisors displace lingually and become crowded.

All the three phenomena have been reported, but the most common event is lower incisor crowding.

The path of eruption of the mandibular incisors is upward and forward. The normal internal rotation of the
mandible carries the jaw upward and anteriorly. This rotation alters the eruption path of the mandibular incisors and tends to upright the incisors particularly if excessive rotation is also present. The forward internal rotation of the mandible is more than that of the maxilla; the decrease in arch perimeter is greater in mandible than in maxilla.

The implant studies have confirmed that the changes in anteroposterior position of the incisors have major influence on arch length changes than the molars.

Late incisor crowding has been observed in patients with anterior open bite and backward rotation of the mandible. In this situation, the rotation of the mandible carries the dentition forward, thrusting the incisors against the lip. This creates light continuous soft tissue pressure by the lip, which leads to crowding of the protruded incisors and reduces arch perimeter.

3. Pressure from third molar:

In most individuals, the third molars are impacted because of lack of space. Late crowding develops at about the time of the third molar eruption. The erupting teeth produce pressure that leads to late crowding. Woodside (1970) postulated that in the absence of third molar, the dentition could settle distally in response to forces generated by growth changes and soft tissue pressures. The presence of impacted third molars at the distal end of the lower arch would prevent the posterior teeth from shifting distally, and their presence would guarantee that crowding would develop. This indicates a passive role of third molars in late incisor crowding.

However, late incisor crowding does occur in individuals with congenitally missing third molars. (Vego, Kaplan) This theory does not explain late crowding, so the presence of these teeth is not critical for late crowding.

In addition to these theories, the anterior component of occlusal force (ACF) is also important in the discussion of late lower arch crowding.

Anterior component of force

The primary interest surrounding ACF is because of its possible role in causing mesial migration of teeth and subsequent dental malalignment. The axial inclination of permanent teeth is such that the forces of mastication produce a mesial resultant through the contact points of the teeth, the anterior component of force. ACF is thought to result from the axial inclination of the posterior teeth, which causes these teeth to tip forward during occlusal loading. This tipping force is subsequently transmitted to more anterior teeth through interproximal contacts. The tendency for the teeth to move forward as a result of occlusal forces varies greatly according to the angulations of the teeth with respect to each other and especially affected by the steepness of the occlusal plane. E.H. Angle is cited as having originally called attention to this force. Stallard (1923), Newcomb (1936), Waldran (1942) suggest that ACF could cause malalignment. However, ACF was never measured before 1989.

Southard et al. in 1989 developed an instrument to measure ACF. They developed a tension transducer that was hooked through a perforated 0.0015-inch stainless steel dental matrix strip. The matrix strip was slipped interproximally and withdrawn at approximately 2 to 5 mm/sec. Frictional resistance of withdrawal was measured as the subject was biting on left second molar with axial load of 20 pounds (within the range of normal chewing) and again when the subject was not biting. The distribution of this force and its dissipation were determined for 15 subjects. ACF was calculated from frictional force measurements. They noted that ACF's magnitude was quite large even when generated by functional loads. The ACF applied against the canines during a conservative chewing force on the second molars was 8 to 200 times greater than the minimal force required to produce tooth movement. Much higher forces are generated in persons with greater biting strength. According to Weinstein (1967), continuous soft tissue forces as small as 0.0035 pounds are capable of moving teeth. The ACF progressed anteriorly through the interproximal contacts and not beyond open contacts. In some subjects this force passed beyond the midline and continued around the arch to the canines of the contralateral side.

Southard et al. in 1990 based on their experiments, suggested that malalignment of mandibular anterior teeth was related to the magnitude of ACF and to tightness of interproximal contacts in mandibular posterior segment. ACF can cause dental malalignment in persons who clench, brux or in any other way load posterior teeth axially for extended periods of time. Acar A in 2002 conducted a study to investigate whether a relationship exists between ACF and postretention crowding in mandibular incisors. The study sample consisted of 32 subjects. The average post retention period was 3.2 years.
In the non-extraction group, a strong correlation between ACF and irregularity index was found at canine premolar contact.

In the extraction group, a positive correlation was found between ACF and the irregularity index at the second premolar-first premolar contact but no correlation was found at the canine premolar contacts. They concluded that moderate positive correlation existed between ACF and post retention mandibular arch crowding in subjects treated without extraction.

Studies relating third molars to late crowding

Bergstrom and Jensen (1961)\(^1\) carried out a cross sectional study on 60 dental students of whom 30 had unilateral agenesis of upper third molars, 27 had agenesis of lower third molars, and had one third molar absent or lost. They measured the space conditions and midline displacement on both sides of the plaster casts of those students. The results suggested more crowding in the quadrant with third molar present than in the quadrants with third molar missing. Mesial displacement of lateral segments was found on the side with third molar in mandibular arches but not in maxilla. No correlation between age and the degree of crowding or mesial displacement was found. They observed that the unilateral presence of third molar did not seem to have an effect on the midline. They concluded that the presence of third molar appeared to exert some influence on the development of the dental arch but not to the extent that would justify either the removal of tooth germ, or the extraction of third molar, other than in exceptional cases.

Vego (1962)\(^2\) conducted a longitudinal study on 40 cases with lower third molar present and 27 cases with congenital absence of lower third molars, in untreated arches. The first measurement of arch perimeter was made after the eruption of second molar approximately 13 years average and second measurement was made at average of 19 years. The result of this study suggested that there was significantly greater degree of crowding in the group with lower third molar. He concluded that the erupting third molar could exert a force on approximating teeth. In both groups, arch perimeter loss was observed and some cases without lower third molar, showed an increase in severity of rotated or malaligned teeth. Therefore he suggested that there are multiple factors involved in the crowding of an arch.

Selmer-Olsen's study (1970)\(^3\) suggested that in people with unilateral congenital absence of third molar, there was less crowding on that side of the arch without third molar than on the other side with third molar.

Schwarze (1975)\(^4\) in a long-term study compared a group of 56 patients with third molar germectomy and 49 subjects whose third molars were allowed to develop. He found a significant forward movement of the first molars associated with increased lower arch crowding in non-extraction group.

Lindqvist and Thilander (1982)\(^5\) examined 23 boys and 29 girls with impacted third molars on both sides of the mandible. The impacted molar on one side was removed and the non-extraction side was used as a control. Average age at the time of operation was 15.5 yrs. (13-19 years). Before the operation and annually for three years after the surgery, the study casts and cephalograms were taken. They noted that the space change on the extraction side was improved in relation to the control side in 70 percent of cases. They found a very small beneficial effect, 0.16mm less crowding in the group without third molars compared with the group with third molars. They concluded that extraction could be recommended in severe crowding. The study was not able to predict which patients reacted favorably or unfavorably to removal of third molars in cases of anticipated crowding.

Richardson ME (1989)\(^6\) conducted the Belfast third molar study that is in support of the pressure from behind theory. She examined 51 subjects (22 females and 29 males) with intact lower arches and bilateral third molars present, in the age group of 13 d 18 years. These cases showed more than 1mm increase in crowding on each side. In some quadrants, the increase in crowding was 4mm and only 16% of arches did not show increase in crowding. Mesial inclination of the lower canines is usually considered to be a sign that the buccal segment has moved forward. Three cases showed a distinct mesial inclination and increase in lower incisor crowding during the observation period. She considered third molars as one of the causes of late lower arch crowding.

Studies indicating a lack of correlation between third molar and late crowding

Shanley (1962)\(^7\) in a small cross sectional study, compared lower incisor crowding and procumbency in three groups of subjects with bilaterally impacted, erupted or congenitally absent third molar. He found
no significant differences and concluded that third molars have little influence on crowding or procumbency of lower incisors.

Buschang P H and Shulman (2003) conducted a study on the prevalence of lower incisors crowding in untreated persons in the age group of 15-50 years. A random sample of 9044 individuals was used. They concluded that erupted third molars were not associated with crowding and significant increase in crowding took place during adulthood.

Retrospective studies

A number of studies found no correlation between third molar and late crowding.

Kaplan in 1974 investigated the influence of third molar on post treatment changes in the mandibular anterior crowding. The study included 75 orthodontically treated patients. The pre treatment, post treatment and 10 years post retention study models and cephalograms were examined.

The sample was divided into three groups:
1) First group - 30 persons with both third molars erupted to the line of occlusal plane, in good alignment buccolingually and of normal size and form.
2) Second group - 25 persons with bilaterally impacted third molars, candidates for surgical removal.
3) Third group - 25 patients with bilateral agenesis of mandibular third molar.

Some degree of lower incisor crowding relapsed in the majority of cases. The third molar groups showed no significant increase in crowding, whether premolars were extracted or not. He concluded that the presence of third molar does not produce a greater degree of lower anterior crowding and rotational relapse after cessation of retention. According to Kaplan, the theory that third molar exert pressure on the teeth mesial to them could not be substantiated.

Ades AG et. al., (1990) conducted a long-term study to determine the relation of third molar to changes in the mandibular dental arch. The sample for this study consisted of four groups and subgroups. The groups consisted of premolar extraction, non-extraction with initial generalized spacing, non-extraction, and serial extraction untreated subjects. The subgroups were divided into persons who had mandibular third molars that were either impacted, erupted into function, congenitally absent or extracted at least ten years before post retention records. The mean post retention period was 13 years. (10-28 years) The mean post retention age was 28 years 6 months. (10 years 6 months - 39 years 4 months). They found that mandibular incisor irregularity increased while arch length and incisor width decreased. The third molar subgroups revealed no significant differences in the parameter studied. No significant difference in mandibular growth pattern was found in third molar subgroups. Incisor crowding was not significant between third molar subgroups. They concluded that the third molar removal with the objective of alleviating or preventing mandibular incisor irregularity might not be justified.

Nieke et. al., (1995) in their study of post retention crowding and incisor irregularity considered the presence or absence of third molars, dividing the sample of 226 cases into subgroups; bilaterally erupted, impacted third molars, and bilateral third molars agenesis or extraction. Lower arch crowding was found to be influenced by the presence of third molars. In cases with missing mandibular third molars, less amount of relapse of crowding was seen than in any case with impacted or erupted third molars. On the side of missing third molars, 1.2 mm of less crowding was seen. They concluded that the crowding was statistically significant but clinically insignificant.

Little RM (1990,1999) examined mandibular crowding during the post treatment phase and concluded that mandibular crowding is a continuous phenomenon well into the 20-40 yrs age bracket and beyond. Third molar presence, absence, impacted or fully erupted, seemed to have little effect on the occurrence or degree of relapse.

Fastlicht (1970) compared the degree of crowding in two groups-28 orthodontically treated subjects and 28 cases of teenagers and adults who did not receive orthodontic treatment. He found that the third molars did not correlate with observed crowding. Crowding increased with age and increased in cases with less intercanine width. Crowding of mandibular incisors was more in untreated group and more noticeable in males.

Southard et. al. (1991) measured the mesial force exerted by unerupted mandibular third molars using a technique similar to measuring the anterior component of occlusal force. The sample consisted of 14 males and six female patients. Their hypothesis was that the mesial force exerted by unerupted third molar increases.
tightness of all proximal posterior tooth contacts and that surgical removal of third molar relieves tightness by eliminating this force.

A 0.038mm thick stainless steel strip was slipped between two teeth and withdrawn with a digital transducer. The contact tightness was measured bilaterally in twenty patients with bilaterally unerupted mandibular third molars, in upright position, immediately before extraction of third molar. The patients were placed in a supine position on the operating table and third molars were extracted unilaterally. Immediately after unilateral third molar extraction, the tightness of proximal contacts was measured. Contact point tightness decreased bilaterally to the same extent. If a significant mesial force from third molars existed, the tightness of proximal contacts would have reduced on the side of extraction of third molar.

They were unable to detect a mesial force exerted by unerupted third molars. They observed that the change of posture relieves the proximal contact tightness dramatically. The second part of the experiment was conducted to determine the effects of postural changes on proximal contact tightness where no surgery has been done. In ten subjects the mean decrease in proximal contact tightness was noted in mandibular posterior contacts two hours after the patient had been moved from upright to supine position. When a steel strip is slipped between the teeth, they will eventually separate and tightness of contact point between the teeth will decrease as a result of viscoelastic relaxation of periodontal ligament. However, This finding demonstrated that the observed effect of posture was not simply a result of viscoelastic relaxation of periodontal ligament.

They concluded that if a significant third molar pressure existed, it should have been detectable in these patients. Its magnitude is too small to be measured by that technique.

Richardson (1992) studied lower arch crowding in the young adults between 18-21 years in untreated individuals with intact lower arches. The sample consisted of 33 men and 32 women. The mesial drift of first molars was measured on 60-degree cephalometric radiographs. The mesial drift of molars was not clinically significant in this age group. She concluded that the lower arch is stable in terms of mesial drift and tooth alignment, regardless of third molar status and continuing mandibular growth.

Pirittiniemi et al. (1994) evaluated the effect of impacted third molar removal on 24 individuals in the third decade of life. Casts were examined before and one year after extraction of third molar. They found slight distal drift of second molar but no significant change in the lower incisor region.

Vander Schoot et al. (1997) examined 99 patients before and after treatment and at least three years after end of retention. The sample was divided into four groups- subjects who had third molars erupted, impacted, were extracted and congenitally missing. No significant differences in the irregularity index were found between the different groups. They concluded that no relationship exists between crowding and the presence or absence of third molars.

Harradine et al. (1998) conducted a prospective randomized control study to evaluate the effect of extraction of third molars on the late lower arch crowding. 164 subjects participated in the study following completion of orthodontic treatment. The number of patients who returned for follow-up was 77. They randomized 44 of these patients to have third molars removed. There was no evidence of responder bias. All the patients had third molars with the proposed path of eruption through the adjacent second molar. No treatment in the lower arch or only premolar extraction was carried out. No statistically and clinically significant decrease in crowding (1.3mm) was observed in the third molar extraction group. They concluded that the removal of third molar to reduce or prevent late crowding could not be justified.

Al Balkhi et al. (2004) carried out a post orthodontic treatment pilot study in the age group of 14-19 years to evaluate the role of different third molar conditions on recrowing of lower anterior teeth in the absence of tight interproximal contacts. Proximal stripping was done to relieve the tightness of interproximal contacts between the lower incisors. The cases were followed up for one year. The results of this pilot study did not show correlation between different third molars conditions and lower incisor crowding.

**Discussion**

Bergstrom and Jensen's study (1961) suggested a positive role of the third molars in late crowding.

Vego (1962) noted that the erupting third molars could exert a force on the adjacent teeth. He observed late crowding in subjects with congenitally missing molars.
Therefore, he suggested that there were multiple factors involved in the crowding of lower arch.

Woodside DG (1970) postulated that in the absence of third molar, there is distal settling of the whole mandibular dentition during the growth period and the presence of third molar would prevent distal settling.

Schulhof RJ (1970) compared Vego and Kaplan's work. According to him, if different statistical tests were applied in Kaplan's study, their findings would support Vego's conclusions. He reached at a conclusion that the third molars were a factor in late incisor crowding.

Ricketts RM et. al. (1976) stated that removal of the third molar bud at the age of seven to ten years is surprisingly simple and relatively atraumatic.

Lindqvist and Thilander (1982) were in favor of the opinion that the third molars cause late crowding in some individuals.

Richardson ME (1989) conducted the Belfast third molar study that is in support of the pressure from behind theory. She examined 51 subjects (22 females and 29 males) with intact lower arches and bilateral third molars present, in the age group of 13 and 18 years. These cases showed more than 1mm increase in crowding on each side. In some quadrants, the increase in crowding was 4mm and only 16% of arches did not show increased crowding. Mesial inclination of the lower canines is usually considered to be a sign that the buccal segment has moved forward. Three cases showed a distinct mesial inclination and increased lower incisor crowding during the observation period. She considered third molars as one of the causes of late lower arch crowding.

Richardson ME (1990) studied the effects of removing second molars on late lower crowding and observed a slight distal shift of second molars and decrease in lower incisor crowding.

Richardson ME (1996) observed greater increase in third molar space, forward movement of the second molar and increase in interincisal angle in the group with crowding than the non-crowding group between the ages of 12.5 and 15.5 years.

Vasir NS, Robinson RJ (1991) reviewed the role of third molars in late incisor crowding and noted that it indicates a small but statistically significant relationship.

Graber (1970) opined that the third molars do not cause crowding and its role has been misunderstood in orthodontics. But terminal horizontal growth and disturbances in musculature can cause crowding if there is no room.

Bramante MA (1990) concluded that the vast bulk of evidence indicates insignificant role of third molars in late crowding.

According to Sampson WJ (1995) it is illogical to assume a single cause as the simple observation if crowding belies the complexity of possible interacting factors.

Sinclair JH (1996) concluded that carrying out a procedure that has a significant risk of morbidity without good reason is unacceptable. We need to reconsider our whole approach to third molar removal.

Vego's study (1962) showed a slight increase in crowding of 0.8 mm in the group with the third molars present.

Fastlitch's study (1970) that included an untreated control group suggested that the third molars do not cause late crowding.

Schwarze (1975) observed a decrease in crowding of 1.5 mm on the side of prophylactic germectomy of third molar. The extractions were not randomized in this study.

Lindqvist and Thilander's (1982) study showed a beneficial effect of 0.16mm less crowding on the side of extraction of the third molars.

Little RM (1990,1999) observed that the absence or presence of third molars seemed to have little influence on the occurrence of late crowding in untreated individuals, and the degree of relapse of crowding in orthodontically treated persons.

Southard et al (1991) were unable to measure the mesial force exerted by third molars using a technique similar to measuring anterior component of force. They concluded that it was too small in magnitude to be detected by that technique. It indicates that pressure from back of the arch is not significantly influenced by third molar extraction.

Richardson (1992) reported that the forward mesial movement of first molar was not related to third molar status in 18-21 years age group.

Nieke et. al. (1995) reported less relapse of crowding (1.2 mm) on the side with third molars missing. This was statistically significant but clinically insignificant.
There is only one prospective randomized control trial regarding the third molars and late lower incisor crowding. In Harradine's randomized clinical trial, (1998) extraction of third molar produced a maximum benefit of 1.3 mm. This was considered as statistically and clinically insignificant.

Buschang PH and Shulman (2003) concluded that the erupted third molars were not associated with increased mandibular crowding in untreated individuals.

Late crowding has been reported in individuals with missing third molars. It clearly indicates that other etiologic factors are more important than third molars.

The implant studies have confirmed that the changes in anteroposterior position of the incisors have major influence on arch length changes than the molars. The latest evidence suggests that the third molars do not have a significant role in the development of late mandibular arch crowding and should not be extracted to prevent late lower arch crowding.

**Limitations of various studies**

Similar studies show dissimilar results particularly when observing cases of third molar extraction or agenesis. They may differ genetically in tooth size and arch length and the subjects cannot be matched in all aspects.

In Schwarz's study of prophylactic germectomy, the basis for extraction was not described. He did not randomize extraction of third molars.

Nieke et al found clinically insignificant increase in post retention crowding (1.2 mm). The extraction and non-extraction groups were unmatched. The missing third molars were the result of agenesis rather than extraction and the groups were not matched.

It is difficult to compare the changes in lower arch alignment in untreated arches with those of orthodontically treated arches. The factors related to treatment and relapse tendency can influence the amount of crowding observed. The factors contributing to post retention crowding are:

(a) Arch width reduction following increase during treatment
(b) The amount and direction of tooth movement
(c) The interincisal angle
(d) The relationship of the incisors to the soft tissues at the end of the treatment
(e) Periodontal degeneration
(f) The natural relapse tendency.

The methods of measuring the changes in the amount of crowding also differ in these studies.

Different age groups found in these studies make it difficult to compare the results.

Untreated control groups were not included in most of the post retention studies.

**Consensus development conference report on removal of third molars**

National Institute of Dental Research in 1979 and American Association of Oral and Maxillofacial Surgery in 1993 sponsored it. Some of the points of consensus were:

1. Crowding of the lower incisors is a multifactorial phenomenon that involves a decrease in arch length, tooth size, shape and relationship, narrowing of intercanine dimension, retraction of incisors, and growth changes occurring in adolescence. Therefore, it was agreed that there is little rationale based on the available evidence for the extraction of third molars solely to minimize present or future crowding of the lower incisors. If adequate room is available for third molar eruption, every effort should be made to bring these teeth into functional occlusion.

2. Orthodontic therapy, in both maxillary and mandibular arches, may require posterior movement of both first and second molars by either tipping or translation, which can result in impaction of third molars. To avoid impacting third molars and to facilitate retraction, it may be deemed advisable in some cases to remove third molars before starting retraction procedure.

3. Although there are orthodontic reasons for the early removal of third molars, the consensus was that enucleation of third molar buds at seven to nine years of age is not acceptable. This is because the present predictive techniques for third molar eruption or impaction are not highly reliable and should be used with caution.

**Current trends for third molar extractions**

The third molars are routinely removed for three reasons:

1. All impacted third molars are potentially pathogenic therefore prophylactic removal should be done to eliminate the risk.
2. The presence of third molar can cause late incisor crowding.
3. Removal during adolescence and young adulthood reduces the risk of operative and postoperative complications in older patients.

Nieke et al. (1994) evaluated orthopantomograms of 58 orthodontically treated patients with asymptomatic impacted third molars. In a 15-year follow-up, they could not find the predictive value of age, period of impaction, extent of space deficiency, developmental stage, level of eruption, and bone conditions. They suggested that third molars should be periodically evaluated.

Song et al. (1997, 2000) carried out systematic reviews of literature on third molars and concluded that there is no reliable research evidence to support prophylactic removal of disease-free impacted third molars. They concluded that there is little justification for the removal of pathology-free impacted third molars.

Kruger et al., (2001) observed complete eruption of some radiographically apparent impacted third molars (other than horizontal impactions) between 18-26 years, and the low incidence of pathosis associated with impacted third molars.

According to Pasqualin, Erniami et al., (2002) the current trend for third molar extraction is a more conservative clinical approach rather than an aggressive extraction policy.

The evidence suggests that the most appropriate treatment for asymptomatic, pathology-free impacted third molars in young adults is observation instead of prophylactic removal.

**Recommendations for future research**

The studies that include untreated individuals provide a better insight to the cause and effect relationship of third molars and late mandibular incisor crowding than the post retention studies.

1. Although data from observational studies is useful, well-designed randomized control trials should be conducted in untreated subjects to compare the effect of prophylactic removal of impacted third molars with deliberate retention, on late lower incisor crowding.
2. Randomized control trials should be conducted to evaluate late lower incisor crowding in orthodontically treated subjects with the inclusion of an untreated control group.

**Conclusions**

1. Long-term studies in untreated individuals do not suggest evidence of a cause and effect relationship between third molars and late mandibular incisor crowding.
2. Asymptomatic and pathology-free third molars should not be extracted to prevent late lower crowding in untreated individuals.
3. The asymptomatic and pathology-free third molars should not be extracted to prevent post retention crowding.

**Communications**

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