# A Longitudinal Study Of Mandibular Arch Perimeter

LEROY VEGO, D.D.S., M.S.
*Granada Hills, California*

## INTRODUCTION

The influence of the lower third molar in its progress toward maturity and its relationship to crowding is presented in this study. "Crowding" is defined by the author as loss of arch perimeter which can be manifested in the arch by closure of space or teeth slipping their contacts with resultant rotations and/or movement of teeth.

A review of the literature makes it apparent that the effect of the lower third molar has been a provocative subject for many years. A majority of the investigators have stated that the third molar can cause crowding in the anterior segment of the arch.

In 1937, Selmer-Olsen conducted a study on sixty-three jaws of Norwegian Lapps, the Skolts. These were not living subjects. He noted generalized spacing in the young. In the older individuals there were crowded incisors and no spacing. He was of the opinion that there was a definite forward movement as a result of the erupting molars. In studying jaws with congenital absence of third molars on both sides, he states,[21] ". . . there is to some extent some marked crowding which goes to indicate that the eruption of the third molars in the lower jaws is, at all events, a contributory factor only and that there are other considerations present of, in some respects, greater importance".

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In the early forties, Broadbent published his conclusions by writing, "Factual evidence collected by the Bolton Study for the past twelve years would acquit the wisdom teeth of the "fifth column" charges and include them along with the incisors as co-sufferers resulting from the failure of the facial skeleton to attain its complete adult size and proportions".[6]

Salzman[20] and Strang[23] support this point of view.

Recently Bergstrom and Jensen of Ireland studied casts of unilateral aplasia of the third molars.[5] Their conclusion was, "There was a definite mesialward displacement of the lateral segment of the side of the third molar in the mandible. In the maxilla no such difference could be demonstrated for all cases between the two sides of the jaw, but when only cases with an erupted third molar were examined, a statistically significant difference between the two sides of the jaw was obtained also in the maxilla."

A major part of this study is concerned with arch perimeter. The procedure for obtaining this measurement is explained under Materials and Methods. In reviewing the literature, it was found that there have been some excellent longitudinal cast studies on the various arch dimensions.

Moorrees, in 1958, reported the findings of a longitudinal study of dental development between three and eighteen years of age. The material was gathered from the Forsyth Dental Infirmary for Children. His findings were that the arch circumference in the man-

dible is 3.4 and 4.5 mm smaller in the average male and female, respectively, at eighteen years of age than at five years of age. In this same study the arch length was investigated. Moorrees stated that the arch length decrease from fourteen to eighteen years of age is minimal.[17] Upon examining the charts presented, this change is less than 0.5 mm. His arch measurement consists of the distance between a line tangent to the labial surfaces of the central incisors and a line connecting the most dorsal points on the distal surfaces of the deciduous second molars or the second premolars. Barrow and White, utilizing the same method of measuring arch length, found that from the ages of twelve to thirteen and one-half years of age the mandibular dental arch decreased 0.67 mm. This was associated with closure of the interproximal space of the posterior teeth. In discussing their findings they stated, "In many cases the length of the dental arches continued to decrease through 17 or 18 years of age. We found three main causes for this decrease following the replacement of all primary by permanent teeth. They were: (1) closure of the interproximal spaces of the posterior teeth, (2) lingual tipping of the anterior teeth, especially noted in the maxillary incisors, (3) normal wear of the proximal contact surfaces of all teeth.

Our findings show in general, that the permanent teeth through the years move and wear in many ways resulting in a shortening of the dental arches."[4]

In 1951 Brown and Daugaard-Jensen did a longitudinal study of twenty-four serial casts taken at an average of 12 years, 10 months, and 21 years, 6 months. In this study an arch perimeter decrease was found in all but one case. The mean decrease was 1.7 mm.[7]

Arch perimeter loss measurements are not directly comparable because of the differences in the method of measuring.

Another phase of this study is concerned with the total mesiodistal tooth diameters of lower first molar to lower first molar. Mesiodistal tooth diameters of males in a group with a full complement of teeth were measured and compared with mesiodistal tooth diameters of males with congenital absence of lower third molars. This same procedure was followed for females. The purpose of this was to reveal any difference in tooth sizes of individuals with congenital absence of both lower third molars.

## Materials and Method

A longitudinal cast study was carried out on two sample groups, not treated orthodontically. One group had congenital absence of both lower third molars while the other group had a complete dentition. An arch perimeter study was conducted on these groups. An individual's arch was measured twice; first, after the eruption of the second molar, and second, at an age past seventeen. It is within this time that the third molar would have exerted most of its eruptive influence, if there be any influence. The arch perimeter was measured in the first and second serial casts of each individual and the difference recorded. The average difference in arch perimeter of one group was compared with the other group.

The method used to measure the arch perimeter of the casts was that of Lundstrom.[14] The precision and ease of this method indicated a satisfactory means of measuring arch perimeter. The space in the dental arch was determined in six sections of each jaw for each pair of teeth (Fig. 1 — left). Section 1 includes M1 and P2 and as points of measurements the distal contact points of M1 and P2 respectively were used. Section 2 includes the following pair of teeth, P1 and C, etc. If a medial diastema had occurred, this was then measured se-

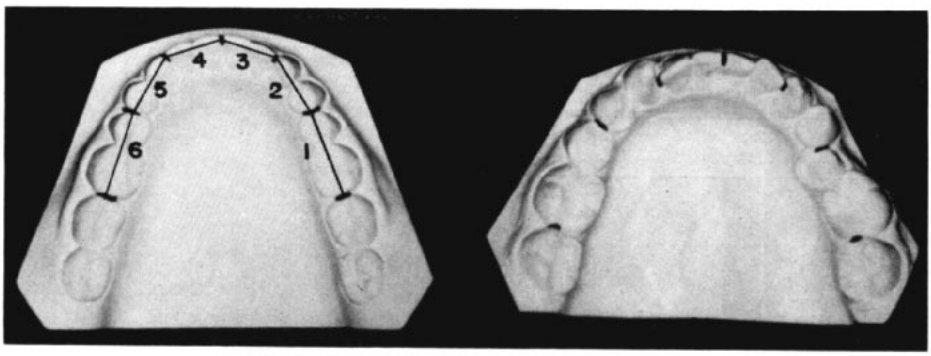


Fig. 1 — left The arch perimeter is measured as the sum of the six sections. Black dots indicate the contact points. Right, in measuring a severely crowded arch the contact points of the teeth most nearly in normal alignment are used.

parately and, because of this fact, the total absolute space in the dental arch consisted of six measurements of the sections and in some cases the breadth of a medial diastema.

If a tooth was out of alignment in an area to be measured, the point of contact of the teeth most nearly in normal alignment was used as the point of measurement (Fig. 1 — right). This was also true of the anterior teeth. A vernier caliper with sharp points was used to make the measurements. The total of the six measurements was used as the arch perimeter.

The cases from the Bolton Study were selected without regard to the state of occlusion and were considered acceptable on the following basis: (1) must have a full complement of teeth (the natural exception to this is the group without lower third molars), (2) no known orthodontic treatment, and long term records of individuals available so as to exclude the possibility of early orthodontic treatment, (3) serial lateral and frontal cephalometric roentgenograms, (4) plaster casts for each case (the casts were made from compound bites using Kerr modeling compound), and (5) the study was limited to Caucasians.

From an acceptable total of one hundred eighty-four cases there were twenty-five which had congenitally missing lower third molars. This made up the first group. Forty cases with complete dentition were selected at random from the remaining one hundred fifty-nine cases to comprise the second group.

## Findings

In the total number of acceptable cases there were 116 males and 68 females. In the selected sample with third molars a similar male to female ratio was found—27 males and 13 females. In the sample without lower third molars there were 10 males and 15 females. The explanation for a reversal of this ratio in the latter group is simply that females are more affected by the congenital absence of lower third molars. This same ratio of females to males with congenital absence of third molars was reported by Hellman in 1936. His sample was larger and was based on the absence of any third molar. In the report he stated, ". . . among the 261 males, 57, or 21.67 per cent, have congenitally missing molars, among the 172 females it is 53, or 30.81 per cent."[13]

In the cases used, the average age of the patient when the first cast was measured was 13 years, 3 months; the average age at which the second cast was measured was 18 years, 9 months. This difference yields a mean interval

TABLE I

FREQUENCY DISTRIBUTION OF ARCH PERIMETER LOSS

| Millimeter Loss | Cases with Third Molars | Cases without Third Molars |
|---|---|---|
| 0-0.4 | 2 | 2 |
| 0.5-0.9 | 4 | 6 |
| 1.0-1.4 | 8 | 1 |
| 1.5-1.9 | 5 | 6 |
| 2.0-2.4 | 5 | 4 |
| 2.5-2.9 | 3 | 4 |
| 3.0-3.4 | 3 | 1 |
| 3.5-3.9 | 2 | 0 |
| 4.0-4.4 | 3 | 1 |
| 4.5-4.9 | 1 | 0 |
| 5.0-5.4 | 2 | 0 |
| 5.5-5.9 | 0 | 0 |
| 6.0 + | 2 | 0 |
| | 40 | 25 |

of 5 years, 6 months.

The frequency distribution for the arch dimension losses is presented in Table I. The statistician advised deletion of figures for the error of measurement, because this study is primarily concerned with differences—not absolute measurements. There were more than 1,560 measurements made to measure the arch perimeters. As a result, errors of measurement would presumably cancel themselves out.

In all 65 cases studied the arch perimeter showed a decrease from the first to the second casts. The mean arch perimeter loss for the group with third molars was 2.5 mm with a range of 0.3 mm to 7.6 mm, the standard deviation being 1.7 mm and the standard error of the mean being 0.26 mm. The mean arch perimeter loss for the group missing third molars was 1.7 mm. There was a range of 0.2 mm to 4.0 mm. The standard deviation for the missing third molar group was 0.9 mm and the standard error of the mean was 0.19 mm. The group with third molars had an average arch perimeter loss greater than that of the congenitally absent group by 0.8 mm. To find out whether this difference was significant, the standard error of the difference between the means was sought.[2] This figure is 0.34 mm. The difference between the means (0.8 mm.) is 2.34 times the standard error (0.34 mm.). Referring to the tables for estimating the significance of deviations, one finds that a difference between the two samples with a mean difference as great or greater than 0.8 mm could have come about by chance only two times in a hundred.[18] This difference is, therefore, considered significant.

The next phase of this study is concerned with the total mesiodistal diameters of the teeth in the lower arch. It was apparent that the sum of the diameters of the teeth varied from the first to the second casts. In the third molar group there was a total 0.06 mm mean increase for the twelve teeth measured. In the congenitally absent group there was a 0.04 mm mean increase. These small changes can probably be attributed to decay, proximal wear, and restorative work—the latter being the most likely influence.

To determine whether the total mesiodistal tooth diameters differed in the two groups, the tooth sizes of the males and females were compared to their own sex in the two groups. In the congenitally absent third molar group, the mean tooth sizes for the males and females were 84.3 mm and 82.3 mm respectively. In the group with third molars the diameters for the males were 85.4 mm and 83.1 mm for the females. It can be noted from these figures that, on the average, the congenitally absent third molar group has slightly smaller teeth. These differences were tested, utilizing the standard error of the difference between means, and were found not to be statistically significant.

## Discussion

The first measurements of arch perimeter were taken after the eruption of the second molars through the oral mucous membrane. The second measurements were taken at an average age of 18 years, 9 months. This interval was selected in order to evaluate the eruptive influence of the lower third molar. It was found that the mean arch perimeter loss was 0.8 mm greater in the cases with lower third molars than in the cases without lower third molars. Since the mean arch perimeter loss of 0.8 mm was found to be a statistically significant difference, the erupting lower third molars were considered the responsible factor.

In the frequency distribution table (Table I), it can be noted that there are only two cases in the congenitally absent third molar group that have arch perimeter losses of 3.0 mm or greater. Yet, in the third molar group there are thirteen cases that have arch perimeter losses of 3.0 to 7.6 mm. This indicates to the author that in cases with third molars there is a greater possibility of detriment to the arch than in cases with congenital absence of lower third molars.

In the third molar group there were a number of cases that had poor tooth alignment in the lower arch. During the eruption of the lower third molars those cases became worse. In the congenitally absent third molar group there was less increase in malalignment during the intervals measured.

Clinically, arch perimeter loss may be observed in the following ways: (1) if there is spacing in the arch, some or all of the space may be lost, (2) one or more teeth may be forced out of alignment in either the anterior or posterior segments, (3) overlapping, or slipping of tooth contacts is common. These events can occur singly or simultaneously in an arch with a great degree of variance.

## Summary

Long term serial records, accumulated by the Bolton Fund, of the developmental growth of teeth and jaws of nearly 5,000 Cleveland children, were used for this thesis.

A serial cast study was conducted on forty cases with lower third molars present and twenty-five cases with congenital absence of both lower third molars. None of the selected cases had had orthodontic treatment. Arch perimeter measurements were then taken. The first measurements were taken after the eruption of the second molar through the oral mucous membrane at an average age of 13 years, 3 months. The second measurement of the individual was made at an average age of 18 years, 9 months. Lundstrom's method to measure arch perimeter was adopted. The total mesiodistal diameters of the lower teeth from first molar to first molar were also recorded.

As a result of this study several observations were made:

1. There was a significantly greater degree of crowding in the group with lower third molars. It is concluded that the erupting lower third molar can exert a force on approximating teeth.

2. Arches with good alignment tended to remain that way.

3. In both groups every case studied presented an arch perimeter loss. During the interval studied, some cases without lower third molars showed an increase in the severity of rotated or malaligned teeth. Although this was not as noticeable as in the cases with erupting lower third molars, it is apparent that there are multiple factors involved in the crowding of an arch.

4. There were more females than males with congenital absence of lower third molars. A three to two ratio was found. This is the same ratio as report-

ed by Hellman in 1936 for congenital absence of any third molar.[13]

5. In the group with congenital absence of lower third molars the size of the teeth was slightly smaller than the third molar group. This difference was tested and found not to be statistically significant.

*17050 Chatsworth St.*

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