Mandibular arch form and late anterior crowding

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ABSTRACT

Background: Postadolescent crowding in the lower dental arch that develops after completion of permanent dentition and during teenage period is a common orthodontic problem and usually occurs in the incisors region. This cross-sectional study aimed to evaluate the distribution of different mandibular arch forms in late lower anterior crowded dentition.

Materials and Method: The research surveyed 73 patients (33 boys and 40 girls) with various severities of late lower anterior crowding assessed by the classical Irregularity Index of Little1, while the mandibular arch form was determined by applying the approach of Raberin et al.

Results: The data declared the sequential distribution of flat, pointed, mid, narrow, and wide forms (37%, 30%, 18%, 12%, 3%) respectively, with no clear gender dimorphism. It appears that this distribution is not greatly affected by the severity of the crowding.

Conclusion: The common feature of reduced anterior arch length in late lower crowded dentition leads to the superiority of the flat arches followed by the pointed form with reduced intercanine width.

Key words: Mandibular crowding, arch form.

INTRODUCTION

Since Angle (1), orthodontists tried to find standardized arch form; however, many findings have confirmed that the ideal dental arch has not single or universal form (2). In contrast, preservation of the original arch form during and posttreatment is critical if stable therapeutic results are to be guaranteed (3-6).

Merz et al (7) described crowding as a function of space required for the mesiodistal diameter of the teeth versus space available on the basis of the width, length and vertical curve of the dental arches. (8) Since those three parameters regarded as vital determinants of the dental arch form, understanding the role of arch form in developing this kind of crowding or at least any reasonable association to specific arch form is clinically meaningful.

The causes of late crowding in the mandibular arch alternative to mesially directed forces have profusely reviewed under the headings: late mandibular growth, skeletal structure and complex growth pattern, soft tissue maturation, periodontal forces, tooth structure, occlusal forces and connective tissue changes (9,10). Although the cause of late lower anterior crowding is undoubtedly multifactorial, little attention has been given to the criterion of arch form.

MATERIALS AND METHODS

All the data were collected from satisfactory diagnostic pretreatment stone models of seventy-three Iraqi orthodontic patients (33 boys and 40 girls) attended to the College of Dentistry.

The age of the sample ranged from a minimal dental age of full complement of mandibular permanent dentition (except third molar) till the age of late teens (below twenties). The participants should satisfy some other criteria:

1. All have class I Angle’s classification, with no history of any orthodontic treatment.
2. Acceptable symmetry of mandibular arch viewed with Schmuth measuring grid (Figure 1).

Determination of mandibular arch form

Mandibular arch form was determined on stone cast by applying the approach of Raberin et al (2) that categorizing the lower dental arch into at least five forms through interpretation of the percentage of deviation of five ratios of independent linear measurements (A,B,C,D,E) from the overall mean values of the total sample (Figure 2).

Each arch form has characteristic percentage deviation values of the five ratios (Figure 3):

Narrow: all sagittal / transverse ratios (A,B,C) are positive
Wide: all sagittal / transverse ratios (A,B,C) are negative
Mid: none of the ratios (A,B,C,D,E) significantly deviates from the average
Pointed: only ratio A has intensity noticeably higher than the average
Flat: only ratio A has intensity noticeably lower than the average

All transverse linear measurements were obtained by using dental Vernier calibrated to tenths of millimeter (Dentauram–Münchner design), while the sagittal measurements were...
obtained by using Schmuth measuring grid calibrated by 2 mm subdivisions (Figure 1).

**Assessment of mandibular anterior crowding**

There are wide extremities of late mandibular anterior crowding ranging from mild undetected irregularity to very severe crowding that might compromise the periodontal health of the teeth.\(^{(11,12)}\) Hence, it is important to find a reliable method for ranking the severity of this crowding. The Index developed by Little in 1975 \(^{(1)}\), was adopted to express the irregularity in numerical score and quantifying the severity.

The scoring method, applied to the stone cast, involved measuring the horizontal linear displacement of the anatomic contact points of each mandibular incisor from the adjacent teeth and the sum of these five measurements represents the severity of lower anterior dentition irregularity (Figure 4):

- 0 = perfect alignment
- 1 – 3 = mild irregularity
- 4 – 6 = moderate irregularity
- 7 – 9 = severe irregularity
- > 10 = very severe irregularity

In this study, measurements were obtained by using the same Vernier caliper. The cast was viewed from above and the Vernier was held parallel to the occlusal plane while the beaks were lined up with the displaced contact points to be measured (Figure 4). All measurements were repeated twice and if mismatched, a third measurement was adopted.

**Statistical analysis**

Descriptive (number, percentage, mean and standard deviation) and inferential statistics (ANOVA and Correlation tests) were applied with the help of SPSS computer program. Illustration figures were used to facilitate the interpretation of the results.

**RESULTS AND DISCUSSION**

### Mandibular arch form distribution

Since we are not dealing with normal teeth alignment, so it is predictable to find that the mandibular arch form distribution within the late lower anterior crowding population is not the same as within normal occlusion subject, in which there is no significant difference reported in the prevalence between narrow, wide, mid, pointed and flat arch forms (23.7%, 19.7%, 18.7%, 19.4% and 18.3%) respectively, proved by Raberin et al \(^{(2)}\) themselves. However, depending on recent (2005) Iraqi study,\(^{(13)}\) a quite different respective distribution for the orderly mentioned arch forms has reported (41%, 30%, 3%, 7%, and 19%).

The late mandibular anterior crowded arches have their own distribution (Table 1 and Figure 5), with the least prevalence for the wide type (3%) that regarded as a reasonable result attributed to the relatively larger dimensions of those arches to accommodate the present teeth and rarely related to crowding.\(^{(14)}\)

**Why flat arch form?**

It was surprising to qualify the flat arch form as having the highest distribution (37%) within this sample. One of the obvious criteria of this arch form is the relatively high percentage of deviation of ratio A below the mean (Figure 3), in which the reduced anterior arch length rather than increased intercanine width is the usual contributory factor for the reduction of this ratio.

This finding leading to the era that mandibular anterior crowding is more accentuated by reduced anterior arch length than reduction of the intercanine width,\(^{(15,17)}\) a finding confirmed by the better negative correlation between the Irregularity Index and the anterior arch length (-0.24) than that between the Index and intercanine width (-0.05); however still weak in both (Table 2).

Again, one of the previously mentioned predisposing factors of late mandibular anterior crowding is the retroclination of the lower incisors under lower lip pressure that demands extra-space for this new more lingual alignment of the fan-shaped mandibular incisors, which regarded as another contributory factor in reducing the anterior arch length,\(^{(10)}\) and hence rendering the arch form into the flat type. This phenomenon is synergized by the relative mesial tipping of the mandibular canines due to the mesially directed forces,\(^{(8)}\) which helps in reducing the anterior arch length (Figure 6).

Those two factors will not only predispose to crowding, but also may help in the transformation of an arch form into the flat type, a factor responsible for the high prevalence of this form in the late lower anterior crowded arches.

**Why pointed arch form?**

The previous paragraphs did not omit the role of the reduced lower intercanine distance as a predisposing factor for crowding.\(^{(15)}\) The reduced intercanine width accompanied by increased anterior arch length is usually associated with the pointed arch form that characterized by a relatively high positive deviation of ratio A (Figure 3). Although the anterior arch length is increased; however, the accompanied reduction of the intercanine width will jeopardize the normal anterior arcade of the lower dental arch and hence compromising the normal alignment of the anterior teeth.\(^{(8)}\) Therefore, it is logical to find pointed form in the second distribution (30%) within the total sample.
The third arch form is the mid-type that still lying in the middle among the distributions of the all five arch forms (18%). The crowding associated with this arch form is usually not associated with the form itself but with the classical tooth size/arch perimeter discrepancy.

Finally, as McKeown said that narrow arches (12%) generally predispose to crowding (i.e. the well aligned narrow arches tend to crowd later due to the small transverse dimensions of this form). (18)

**Gender distribution of the dental arch form**

Referring to Figure 7, it was clear that there is no marked difference in the distribution between males and female regarding the mid, pointed and flat arch forms, where most of the sample size concentrated with slight overall predominance of females that may be attributed to the larger number of females seeking for orthodontic treatment that imposed on the whole sample male/female proportions. These findings agreed with many investigators (2); however, Al-Mulla and Al-Joubori (19) concluded that all mandibular skeletal dimensions are larger in males than females; hence girls might be more susceptible to mandibular crowding than boys. Adding to that, some increase in the jaw length and width is to be expected in teenage subjects (20) and it is not surprising to find a greater increase in males than females. (21)

Meanwhile, narrow arch form is the only one that recorded a predominance of male over female, which still questionable and counteract with the narrow arches distribution in subjects with normal occlusion (2), yet still relatively agreed with others. (13)

In the wide type, it is not wise to adopt the 100% of females’ predominance as a standard due to the rarity of the patients in this group, which is statistically not reliable (two only).

**Arch form distribution according to the severity of late mandibular anterior crowding.**

Ranking the severity of late mandibular crowding demands the division of the sample into 4 subgroups according to the Irregularity Index of Little (1): (Table.1, Figure 8)

1. Mild irregularity (1-3 mm): There is a predominance of the flat arch form (33%) with minimal percentage of the wide arch form (6%). This figure superimposed on the general arch form distribution of the total sample; however, the narrow (22%) and pointed (22%) arch forms are equally present in this group.
2. Moderate irregularity (4-6 mm): Here, as the severity of teeth irregularity progress, the wide (9%) and narrow (8%) arches (which is regarded as a predisposing arch for crowding) (15) fade down with greater predominance of pointed (40%) and flat (28%) forms because of reduced intercanine and anterior arch length, respectively.
3. Severe irregularity (7-9 mm): Although the size of the sample in this group is still low, the distribution of the patients regarding the arch form still progressed in the same general pattern with a predominant flat arch form (60%).
4. Very severe irregularity (>10 mm): Similarly, the flat (40%) and pointed (25%) arches were the most predominant, with one unpredictable wide arch form (with extra-large mesiodistal dimension of the teeth in which the arch can not accommodate properly).

Conversely, no statistically significant difference was reported when comparing the means of the Irregularity Index of the four major arch forms (excluding the wide type), a result that defends any association between each form and the degree of severity of the anterior crowding (Table.3).

**Clinical implication of the study**

Since the lower arch represents the basic foundation on which the occlusion would be built on (22), knowledge about the form of the mandibular dental arch is of at most importance for orthodontists even more than the maxillary one. On the other hand, preservation of the original mandibular arch form, even in crowded condition, is mandatory for securing stable posttreatment results. (8) However, stretching of the late lower crowded arches should not be only on the expense of pushing the incisors labially, but on the distal driving of the mesially tipped canines to resolve the crowding, restoring the original arch form and ensuring stable alignment of the lower anterior segment. Keeping in mind choosing the near ideal preformed arch wire that characterized by the relatively similar lower arch dimensions. As with many orthodontic controversiers, the truth probably lies somewhere in between; however, applying those previously mentioned notes in clinical practice is critical when treating late lower crowding if long-term results are to be preserved.

**REFERENCES**


### Table 1: Lower arch forms distributions according to the severity of late crowding

<table>
<thead>
<tr>
<th>Number</th>
<th>Patients' distribution (Irregularity Index)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>Narrow</td>
<td>9</td>
</tr>
<tr>
<td>Wide</td>
<td>2</td>
</tr>
<tr>
<td>Mid</td>
<td>13</td>
</tr>
<tr>
<td>Pointed</td>
<td>22</td>
</tr>
<tr>
<td>Flat</td>
<td>27</td>
</tr>
<tr>
<td>Total</td>
<td>73</td>
</tr>
</tbody>
</table>

### Table 2: Correlation of the irregularity index with the mandibular anterior arch length and intercanine width

<table>
<thead>
<tr>
<th>Irregularity Index (mm)</th>
<th>Anterior arch Length (1…3 mm)</th>
<th>Intercanine width (3…3 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- 0.24</td>
<td>-</td>
<td>- 0.05</td>
</tr>
</tbody>
</table>
Table 3: ANOVA table declares no significant difference between the severities of late lower anterior crowding of the four major mandibular arch forms at p-value 0.05

<table>
<thead>
<tr>
<th>Arch Form</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>df</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrow</td>
<td>9</td>
<td>7.3</td>
<td>5.783</td>
<td>3</td>
<td>0.143</td>
<td>0.934 NS</td>
</tr>
<tr>
<td>Mid</td>
<td>13</td>
<td>6.723</td>
<td>3.909</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pointed</td>
<td>22</td>
<td>6.727</td>
<td>3.603</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flat</td>
<td>27</td>
<td>7.37</td>
<td>3.785</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Forms</td>
<td>71</td>
<td>7.044</td>
<td>3.970</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1: Schmuth grid used to assess symmetry and sagittal measurements

Figure 2: Linear measurements and ratios to determine the mandibular arch form

Figure 3: Each of the 5 forms has characteristic deviation of the 5 ratios from the mean
Irregularity Index

\[
\text{I} = 2.4 + 1.9 + 0.2 + 2.3 + 1.8 = 8.8 \text{ mm}
\]

Figure 4: Manual of the irregularity index to count

Figure 6: Flat arch form characterized by highly reduced anterior arch length compromised by the backward lip pressure and forward migration of canines and buccal dentition.

Figure 7: Lower arch form distribution according to genders

Figure 8: Mandibular arch form distributions according to the severity of late lower anterior crowding.