

**ARCH LENGTH ANALYSIS AND DEVELOPMENTAL ARCH CHANGES**

To be able to know if adequate room exists for incoming permanent teeth, it becomes important to know the mesio-distal widths of these teeth prior to their eruption into the mouth. This knowledge must, however, be coordinated with any natural development or enlargement of the arches that might typically occur as certain teeth erupt.

There are three specific areas in the mouth that are critical and often important to know if sufficient room will be available during eruption. These areas are:

- (a) The lower incisal region as the deciduous incisors are displaced by their erupting permanent replacements;
- (b) The upper permanent lateral incisor areas - whether there will be sufficient room for the erupting adult laterals;
- (c) The upper permanent canine areas and whether sufficient room will be available when the adult canines erupt into place.

In each of these areas, normal arch development or enlargement typically takes place provided the permanent teeth erupt without displacement or rotations. In those cases with less than ideal eruption involving rotations and/or displacement of the incoming adult incisors and canines, the degree of natural lower arch enlargement can be significantly reduced by 1.3 mm. (mean) or 39%. In fact an ideal developing arch can increase by as much as 5.5 mm. in the lower and 7.0 mm. in the upper<sup>1</sup>. Therefore, it is important to know two factors in order to predict the outcome of this eruption. The first factor is to estimate the arch increase that should occur when the teeth erupt without rotations or displacement, and the second factor is the predicted sizes of the incoming permanent teeth.

**Ideal Natural Lower Arch Development:**

The development or enlargement of the lower arch, provided ideal (non-rotated or non-displaced) adult incisor eruption takes place, will increase as follows:

- (a) 1.5 mm. as the two lower permanent centrals erupt;
- (b) 1.5 mm. as the two lower permanent laterals erupt; and

- (c) 0.5 mm. additional lower incisal arch increase for 6 months following the full eruption of the laterals.

**Arch Length Analysis - Lower Incisors:**

The mesio-distal size of the unerupted permanent lower lateral incisor can be predicted from the size of the already erupting lower central by simply adding 0.5 mm. to the width of the permanent central. Typically, one will estimate the available space (the space that is available for the adult teeth to erupt into) around the lower arch from the mesial of one lower deciduous canine to the mesial of the other canine along the curvature of the existing or ideal arch. This can easily be done by bending a soft brass wire from canine to canine (available in any hardware store: 22 gauge or .026" round), or by an alternative method of Xeroxing the occlusal surfaces of the models and measuring along the arch curvature using an architectural planimeter. Then one figures the required space (the space that will be required to have straight adult incisors once they are fully erupted) by measuring the mesio-distal width of the first erupting lower permanent central and multiplying by 4 (for the four incisors) and adding 0.5 mm. for each lateral (since the lateral is approximately 0.5 mm. larger mesio-distally than either central). When the required space is subtracted from the available space, the arch shortage or excess is obtained. Any arch analysis during the eruption of the adult incisors is further complicated by the changes in the size of the arch that typically show increases as the adult incisors erupt. Therefore, one must take this into consideration when analyzing the arch shortage or excess during this period by adding this amount to the available space calculations. If the case is expected to have interproximal permanent incisal spacing, this arch increase may be minimal or even non-existent.

If the size of the incoming lower permanent incisors are calculated to be 21 mm. (where the central is 5mm. and the four incisors would be  $5 \times 4 + 1 = 21\text{mm.}$ ), the available space can be 17.5 mm and still be expected to have straight teeth (provided only the lower centrals are beginning their eruption into the mouth:  $17.5 \text{ mm.} + 3.5 \text{ mm.} = 21 \text{ mm.}$ ). If the lower adult centrals are already erupted, then only 2 mm. of natural expansion of the lower arch still remains as the laterals erupt. It is, therefore, possible to estimate if there will be sufficient room for the erupting lateral if the mesio-distal width of this tooth is known from the size of the central (by adding 0.5 mm. to the width of the central), and then measuring the available space for the lateral and adding 1.0 mm. to this distance (since there is a 2.0 mm. increase in the width circumference as both adult laterals erupt).

### **Ideal Natural Upper Arch Development:**

The development or enlargement of the upper arch, provided ideal (non-rotated or non-displaced) adult incisor and canine eruption takes place, will increase as follows:

- (a) 2.5 mm. as the two upper permanent centrals erupt;
- (b) 1.0 mm. as the two upper permanent laterals erupt; and
- (c) 2.5 mm. as the two upper permanent canines erupt.

### **Arch Length Analysis - Upper Incisors:**

In the upper arch, it often is important to estimate if sufficient space for the erupting permanent lateral incisor will be available. Since there is a natural increase of 1.0 mm. while both laterals erupt, there is, therefore, 0.5 mm. increase on each side. The size of the adult lateral can be approximated from either the mesio-distal width of the upper or lower permanent central width. If the width of the upper central is 8.5 mm., the width of the lateral will be expected to be 6.5 mm. (8.5 mm. - 2.0 mm. = 6.5 mm.). If the available space for one lateral is 6.0 mm., there will be sufficient room since the arch expansion will be 0.5 mm. as this lateral erupts. It should be mentioned that the maxillary lateral incisor is the most frequently distorted tooth in size and shape and any such variation from a normal shape should be checked on the radiographs.

### **Arch Length Analysis - Upper Canines:**

At a later time it might be important to predetermine the size of the unerupted adult maxillary canines. The easiest way is to subtract 1.0 mm. from the width of the upper central. This is helpful in those cases where the upper canine is expected to erupt after the two upper premolars will erupt, and you want to increase the width of the upper deciduous canine by adding bonded material to the distal surface to preserve enough space for the tardy adult canine. In this way, when the canine finally erupts there is enough space for it within the arch due to the increased deciduous canine width. This can be preventively done by stripping the necessary space from the mesial of the deciduous first molar at the time the deciduous canine is bonded, or waiting for the natural exfoliation of the deciduous molar. Naturally, when the first premolar erupts, the mesial of the deciduous second molar should be stripped a similar amount. It must also be mentioned that there is a natural increase of arch size of 1.25mm. (per side) as the permanent canine erupts, provided it erupts straight. If the canine does not erupt ideally, this increase will be reduced or not occur at all. From a diagnostic standpoint, it is better not to anticipate this increase since it is so easy for the canine to erupt either rotated or displaced when space shortage is present.

### **Arch Length Analysis - Premolars:**

Predicting the widths of the upper premolars is important when one is planning to sequentially strip the deciduous molars prior to the eruption of each corresponding premolar to make sure sufficient room is maintained, particularly for the second premolar. Although it is rarely necessary, it is also possible to predict the widths of the lower permanent canine and premolars from the mesio-distal widths of the permanent incisors. It is also important to realize that there are insufficient correlations between the sizes of the deciduous and permanent teeth to warrant estimations of one in order to obtain accurate predictions of the other. Predictions should only be made using the sizes of permanent teeth to estimate sizes of other permanent teeth. It should also be mentioned that variations in sizes of any permanent teeth are possible, so that it is recommended that the sizes not only of the unerupted, but also the teeth being measured in the mouth be checked for normality of size. Predictions, of course, are possible from radiographs, but prior compensations for enlargement are necessary.

#### References:

1. Lewis, S.J., and Lehman, I.A.; A quantitative study of the relations between certain factors in the development of the dental arch and the occlusion of the teeth, *Int. J. Orthod., Oral Surg. and Radiol.*, 18: 1015-1037, 1932.

## **PREDICTING SIZES OF NON-ERUPTED PERMANENT TEETH FROM**

## THE SIZES OF ALREADY ERUPTED ADULT TEETH<sup>1</sup>

### Predicting mesio-distal sizes of adult teeth:

Lateral (lower)	=	Central (lower)	+	0.5 mm.
Central (upper)	=	Central (lower)	+	3.5 mm.
Lateral (upper)	=	Central (upper)	-	2.0 mm.
Lateral (upper)	=	Central (lower)	+	1.5 mm.
Incisors (lower 4)	=	Central (lower) x 4	+	1.0 mm.
Incisors (upper 4)	=	Incisors (lower 4)	+	8.0 mm.
Canine (upper)	=	Lateral (upper)	+	1.5 mm.
Canine (upper)	=	Central (upper)	-	1.0 mm.
Canine (upper)	=	Canine (lower)	+	1.0 mm.
Premolar (upper 1st or 2nd)	=	Central (upper)	-	1.8 mm.
Canine (lower)	=	Central (lower)	+	1.5 mm.
1st Premolar (lower)	=	Central (lower)	+	1.6 mm.
2nd Premolar (lower)	=	Central (lower)	+	1.9 mm.
Leeway space lower per side (canine, both premolars)			=	2.5 mm*.
Leeway space upper per side (canine, both premolars)			=	1.4 mm*.
Low. dec. canine & molars per side (male)			=	23.55 mm;
Low. perm. canine & premolars per side			=	21.32 mm;
Diff. per side	=	2.23 mm MALE		
Low. dec. canine & molars per side (female)			=	23.03 mm;
Low. perm. canine & premolars per side			=	20.36 mm;
Diff. per side	=	2.67 mm FEMALE		
<b>Mean diff. lower (male &amp; female per side)</b>			=	<b>2.5 mm;</b>
Upp. dec. canine & molars per side (male)			=	23.08 mm;
Upp. perm. canine & premolars per side			=	21.78 mm;
Diff. per side	=	1.30 mm MALE		
Upp. dec. canine & molars per side (female)			=	22.46 mm;
Upp. perm. canine & premolars per side			=	21.00 mm;
Diff. per side	=	1.46 mm FEMALE		
<b>Mean diff. upper (male &amp; female per side)</b>			=	<b>1.4 mm;</b>

\* Average of Male & Female

: ARHCNGS.

References:

1. Moorrees, C.F.A.; *The dentition of the growing child*, Harvard University Press, Cambridge, Massachusetts, 1959.