

University of Babylon  
College of Dentistry  
5<sup>th</sup> stage

# Orthodontics

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Lec.5

## Space discrepancy & Space Analysis

### PERMANENT DENTITION ANALYSIS

The aim of space analysis is to determine the space and anchorage requirements for orthodontic treatment.

❖ **Carey's analysis/ Arch perimeter analysis/ Royal London space analysis**


These permanent dentition space analyses are used to *measure the arch length-tooth material discrepancy*.


The teeth measured for determining the tooth size –arch length discrepancy are: **incisors, canines & premolars**.

The idea is to compare the amount of the space available for the alignment of teeth and the amount of the space required to align them properly, that mean we first need to :-

1- Calculate of space available

2- Calculate of space required as explain previously , then apply the formula.....

If Space available – space required = (- ve)  space deficiency (crowding)

If Space available – space required = (+ ve)  space excess (spacing)

## **Malocclusion features to consider in permanent dentition space analysis**

### **Crowding and spacing (tooth material)**

As explain previously , the space required for alignment of teeth can be calculated by measuring the mesiodistal width of the teeth anterior to the 1st permanent molar (incisor, canines & premolars) at maximum contour by using pointed caliper and then collection of these measurements together and compare with arch length available (space available) to determine if there is space excess or deficiency(crowding) . Crowding can be quantified as mild (1-3 mm), moderate (4–6 mm) or severe ( $\geq 7$  mm).

**Note :-** If the second deciduous molars are retained, there will be 0.9mm (lee way space) of space per quadrant available following exfoliation and eruption of second premolars in the upper arch and 1.7mm (lee way space) in each quadrant in the lower arch.

### **Incisor antero-posterior change**

It is necessary to alter the antero-posterior position of incisors. The aim is to obtain 2mm over jet at the end of treatment.

In Class II malocclusions, the upper incisors must be retracted for overjet reduction. Conversely, in Class III malocclusions the upper incisors may be advanced or proclined.

If incisors are needed to be retracted, this requires space. ***Every 1 mm of incisor retraction requires 2 mm of space in dental arch.*** (1 mm per quadrant)

If incisors are needed to be proclined, this creates space. ***Every 1 mm of incisor proclination creates 2 mm of space in dental arch.*** (1 mm per quadrant)

**For example,** if patient presented with over jet of 8 mm and the incisors need to be 8-2=6( amount of excess oj.)

$$6 \times 2 = 12\text{mm}$$

So, 12 mm is a required space for correction of over jet, 6mm for each quadrant.

### Leveling occlusal curves (curve of spee)

Skeletal malocclusions are very commonly associated with an increase in the curve of Spee. Where there is no occlusal stop, the lower incisors may over erupt resulting in an occlusal curve which runs from molars to the incisors (curve of spee).

***Leveling an increased curve of spee requires little mm of space*** depending on the depth of the curve , and we can calculate the amount of space that need for the correction of curve of spee by using the following formula:-

***Depth of curve of spee on both side divided by 2 and adding 0.5mm***

For example if the depth of spee is 3.4mm Rt, 3.2mm Lf.

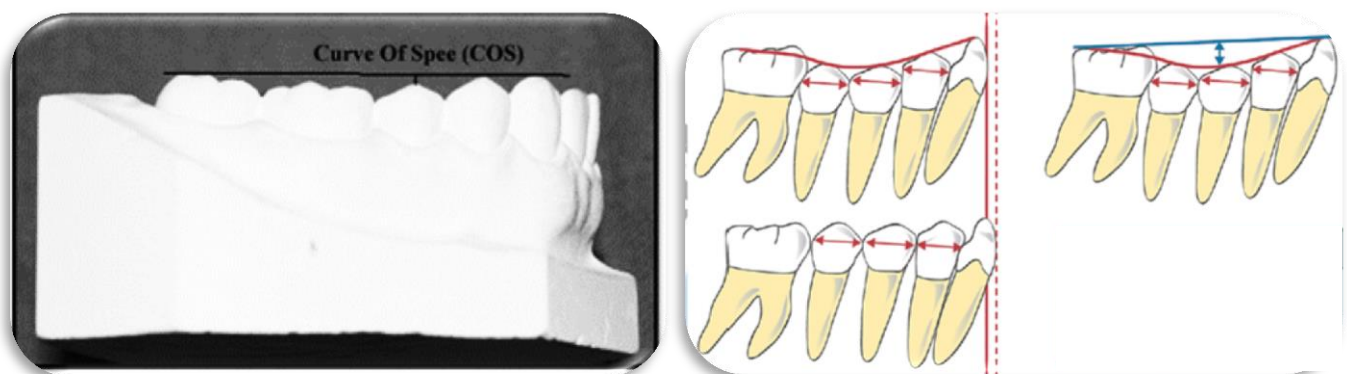
***3.4+3.2=6.6mm (D of CS both sides )***

***6.6÷2= 3.3 mm***

***3.3+ 0.5= 3.8mm (space required for correction of curve of spee on both side).***

The depth of curve is measured from premolar cusp to a flat plane joining the distal cusps of first or second permanent molars and incisal edge of incisors.

A common manifestation of increasing arch length due to flattening deep curves of Spee is labial proclination of the incisor teeth.



### **Arch width change (Arch contraction and expansion)**

Upper arch expansion is undertaken for crossbite correction and is useful in providing space for the relief of crowding and/or overjet reduction.

*Arch contraction requires space while arch expansion creates space. Every 1 mm of expansion creates approximately 0.5 mm of space within the arch. While, arch contraction requires space.*

### **Tooth enlargement (reshaping) or replacement**

Mesiodistal enlargement of microdont teeth and replacement of missing teeth require space. Also, extremely large teeth need to be stripped to normal size. This needs to be taken into account when determining total arch space requirements (space required).

### **Dental midline correction :-**

If the upper or lower dental midline is shift to either side and need to correct during orthodontic treatment , the amount of shift should be consider during the measurement of space required .

**For example** if the patient has upper midline shift to the right side about 2 mm , that mean we should add 2mm to the amount of space required in the upper left side and conversely this will give additional space (space gain) in the upper left side.

**Once all of the above factors** have been considered, it is possible to calculate the space required within each arch.

**Example for calculating space requirement:****Calculating Space Requirement:**

A patient has:

- 7mm overjet
- 4mm curve of Spee in the lower arch (both Q).
- 2mm upper arch crowding
- 2mm lower arch spacing
- requires upper arch expansion of 4mm
- requires 2mm stripping of his large upper central incisors

**Calculate the space requirement.**

- The overjet is increased by 5mm ( $7 - 2 = 5\text{mm}$ ). To reduce overjet to normal 10mm of space is required ( $5 \times 2 = 10\text{mm}$ , 5mm of each side).
- Leveling a 4mm deep curve of Spee requires relatively 2.5 mm of space.
- 2mm space required in upper arch to relief crowding
- 2mm excess in lower arch
- 4mm of expansion creates 2mm of space within the upper arch.
- 2mm IPR of his large upper central incisors create 2mm of space within the upper arch.

Factors of correct malocclusion	Upper arch	Lower arch
Crowding / spacing	+2	-2
Incisor AP movement	+10	0
Levelling the curve of Spee	0	+2.5
Arch contraction / expansion	-2	0
Tooth reshaping / replacement	-2	0
Dental midline shift	0	0
Total	+8	+0.5

**A negative score shows a space gain; a positive score shows space requirement.**

The patient has 8mm space need in the upper arch and 0.5mm space need in the lower arch.

## **Tooth Size Analysis**

For good occlusion, the teeth must be proportional in size. If large upper teeth are combined with small lower teeth, as in a denture setup with mismatched sizes, there is no way to achieve ideal occlusion. Although the natural teeth match very well in most individuals, approximately 5% of the population have some degree of disproportion among the sizes of individual teeth. This is defined as *tooth size discrepancy*. An anomaly in the size of the upper lateral incisors is the most common cause, but variation in premolars or other teeth may be present. Occasionally, all the upper teeth will be too large or too small to fit properly with the lower teeth.

Tooth size analysis, sometimes called ***Bolton analysis or ratio*** regarding to it's developer **Wayne A. Bolton**.

**Bolton Analysis**: is a tooth **analysis** developed to determine the discrepancy between size of maxillary and mandibular teeth. Bolton pointed out that the extraction of one tooth or several teeth should be done according to the ratio of tooth material between the maxillary and mandibular arch in order to get ideal interdigitation, ideal overjet, overbite and good alignment of teeth. This **analysis** measures the Mesio-distal width of each tooth and is divided into two **analyses**

**a- An Overall Analysis** measures the sum of the mesio-distal width of all 12 (first molar to first molar) mandibular teeth and compares them to the sum of the mesiodistal width of the 12 maxillary teeth. The overall ratio known to be equal to 91.3%.

This ratio is calculated using the following formula:

$$\text{Overall ratio} = \frac{\text{sum of mand. 12} \times 100}{\text{sum of max. 12}}$$

- ❖ For establishing ideal overjet, overbite and normal occlusion **overall ratio** should be **equal to 91.3%**
- ❖ If the overall ratio is **less** than **91.3%**, it indicates **maxillary tooth material excess**.
- ❖ If the overall ratio is **more** than **91.3%**, it indicates **mandibular tooth material excess**

**b- The Anterior analysis** measures the sum of Mesio-distal width of the 6 anterior mandibular teeth and compares them to the sum of Mesio-distal width 6 anterior maxillary teeth. The anterior ratio is known to be equal to **77.2%**.

This ratio is calculated using the following formula:

$$\text{Anterior ratio} = \frac{\text{sum of mand. 6} \times 100}{\text{sum of max. 6}}$$

- ❖ For establishing ideal overjet, overbite and normal occlusion **Anterior ratio** should be equal to **77.2 %**
- ❖ If the anterior ratio is **less** than **77.2 %**, it indicates **maxillary tooth material excess**.
- ❖ If the anterior ratio is **more** than **77.2 %**, it indicates **mandibular tooth material excess**.

Then the tooth material excess for upper or lower can calculate by using the following formula:-

$$\text{Maxillary excess} = \text{sum maxillary 12} - \{\text{sum mand. 12} * 100 / 91.3\}$$

$$\text{Mandibular excess} = \text{sum mand. 12} - \{\text{sum max. 12} * 91.3 / 100\}$$

$$\text{Maxillary excess} = \text{sum maxillary 6} - \{\text{sum mand. 6} * 100 / 77.2\}$$

$$\text{Mandibular excess} = \text{sum mand. 6} - \{\text{sum max. 6} * 77.2 / 100\}.$$

**Example :-** what are the Bolton ratio for the following cases as over all and anterior ratio, And what are the amount of excess if present?

**Case no. 1**

Upper Mesiodistal width (mm)	6	5	4	3	2	1	1	2	3	4	5	6
	10	7	7	7.5	7	8	8	7	7.5	7	7	10
Lower Mesiodistal width (mm)	11	7	7	7	6	5	5	6	7	7	7.5	11
	6	5	4	3	2	1	1	2	3	4	5	6

**Maxillary**

**Mandibular**

Total tooth material 12

93

86.5

Sum of ant.6

45

36

**Bolton analysis**

**Over all ratio =sum mand.12 \*100 / sum max. 12**

=86.5 \*100/93

= **93.01%**

❖ If the overall ratio is *less* than **91.3%**, it indicates *maxillary tooth material excess*.

❖ If the overall ratio is *more* than **91.3%**, it indicates *mandibular tooth material excess*

*So there is mandibular tooth material excess*

Mand. Excess =sum mand. 12 – sum max. 12 \* 91.3 /100

=86.5 – 84.909

**Mand. Excess = 1.6 mm**

**Anterior ratio = sum of mand. 6 × 100 / sum of max. 6**

= **36 \*100/45**

=**80%**

❖ If the anterior ratio is *less* than **77.2 %**, it indicates *maxillary tooth material excess*.

❖ If the anterior ratio is *more* than **77.2 %**, it indicates *mandibular tooth material excess*.

*So there is mandibular tooth material excess*

Mand. Excess =sum mand. 6 – sum max. 6 \* 77.2 /100

=36 -34.74

**Mand. Excess = 1.26 mm**



Case no. 2

Upper Mesiodistal width (mm)	<b>6</b>	<b>5</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>
	10.7	7.5	7.6	8.8	6.9	8.2	8.2	6.9	8.8	7.6	7.5	10.7
Lower Mesiodistal width (mm)	<b>10.9</b>	<b>7.9</b>	<b>7.5</b>	<b>7.3</b>	<b>5.3</b>	<b>5.3</b>	<b>5.3</b>	<b>5.3</b>	<b>7.3</b>	<b>7.5</b>	<b>7.9</b>	<b>10.9</b>
	<b>6</b>	<b>5</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>

Maxillary

Mandibular

Total tooth material 12 99.4 88.4

Sum of ant.6 47.8 35.8

**Bolton analysis****Over all ratio = sum mand.12 \*100 / sum max. 12**

=88.4 \*100/99.4

**= 88.93%**

- ❖ If the overall ratio is *less* than **91.3%**, it indicates *maxillary tooth material excess*.
- ❖ If the overall ratio is *more* than **91.3%**, it indicates *mandibular tooth material excess*

*So there is maxillary tooth material excess*

Maxillary Excess = sum max. 12 – sum mand. 12 \* 100/91.3

=99.4 – 96.82

**Maxillary Excess = 2.58mm****Anterior ratio = sum of mand. 6 × 100  
sum of max. 6****= 35.8 \*100/47.8****=74.89%**

- ❖ If the anterior ratio is *less* than **77.2 %**, it indicates *maxillary tooth material excess*.
- ❖ If the anterior ratio is *more* than **77.2 %**, it indicates *mandibular tooth material excess*.

*So there is maxillary tooth material excess*

Maxillary Excess =sum max. 6 – sum mand. 6 \* 100/77.2

=47.8 -46.37

**Maxillary Excess = 1.43mm**