Think Laterally, Go Mathematically: An Innovative Way to Calculate Bolton's Discrepancy in Cases with Impacted or Congenitally Missing Teeth

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Abstract

The incidence of impacted teeth and congenitally missing teeth is fairly increasing. For the achievement of an ideal occlusion and a good intercuspation, we need to identify the interarch tooth size discrepancy. But in cases with unerupted and missing tooth, considering the tooth size of the missing tooth is questionable. Thereby, we have proposed a mathematical concept for the calculation of the mesiodistal width of the missing tooth. The use of this method in our department is a testimony of its usefulness.

Keywords: Impacted tooth; Missing tooth; Bolton's analysis; Mixed dentition analysis; Prediction

Introduction

The incidence of impacted teeth and congenitally missing teeth is fairly increasing [1]. Orthodontic treatment objective is not just aligning the teeth into arch, but also is to fulfil three main goals: Functional efficiency, Structural balance & Esthetic harmony [2,3]. To achieve these goals, proper inter-digitation of opposing teeth is a must, which is only possible if we know the total tooth material in an arch and their interrelationship, so that in case of any discrepancy it could be matched to achieve a good occlusion.

Though there are many model analyses into existence, but Bolton's analysis [4] for the prediction of inter-arch tooth size discrepancy has stood to the test of time. Bolton's discrepancy analysis is one of the diagnostic tools which dictate the extraction plans in an orthodontic practice [5]. There are a few mixed dentition model analysis which predicts the tooth size of canines and premolars based on the mesiodistal width of incisors. A few of the most commonly used analysis are Moyer's mixed dentition analysis [6], Tanaka Johnson mixed dentition analysis [7], Huckaba's analysis [8] etc. The values predicted by these analysis, though varies on different population due to ethnic variability, but still correlates to the nearest of the values which could be used for predicting the approximate values of the mesiodistal width of buccal segments [9].

Thus, thinking logically, If 2 + 2=4, 1 + 3=4, and 4 × 2/2=4, why not 4 - 2=2, 4 - 1=3, and 2 × 16/8=4. Confused?

Simple, if we could predict the mesiodistal width of canine and premolars taking the mesiodistal width of incisors in mixed dentition, then why can't we use the same in adult population. In cases of impacted or missing teeth, we could use the predicted width, and subtract the width of teeth present in a segment, so that we could compute the width of single tooth, which could be used for performing Bolton's analysis.

Here is a case presented as an example to explain the logic and the applicability of the 3 analysis (Moyer's analysis, Tanaka-Johnston analysis, and Huckaba's analysis) for predicting the width of impacted/ missing teeth.

A 15 year old female patient having a class I malocclusion with missing canines in all the four quadrants (13, 23, 33, and 43) and an unerupted upper right second premolar (15). Due to missing teeth, Bolton's analysis was not applicable. But as the case demanded tooth size discrepancy prediction, we tried to go round the way to estimate the tooth material values. The measurement of the teeth in each quadrants are as follows: **Table 1**.

Therefore, to find the mesiodistal tooth width of 15, we considered the opposing side's premolar width and also correlate it with the Huckaba's analysis which considers the use of radiographic width and the actual width of tooth. The formula is as follows:

X/X'=Y/Y' where

X is the radiographic width of adjacent tooth.

Table 1 Measurement of the teeth.

Tooth number (FDI System)	16	15	14	13	12	11	21	22	23	24	25	26
Tooth size (mm)	11	UE*	6.5	-	5.5	5.7	6.5	5.5	-	7	6	11
Tooth size (mm)	10.8	6.8	6.5	-	5.8	5.5	6	5.8	-	6.5	6.8	10.5
Tooth number (FDI System)	46	45	44	43	42	41	31	32	33	34	35	36

UE*: Unerupted tooth

X' is the original width of adjacent tooth.

Y is the radiographic width of tooth to be predicted.

Y' is the original width of tooth to be predicted.

Thus the width of 15 obtained is 6 mm.

Now for the prediction of mesiodistal width of missing canines, we used Tanaka Johnston and Moyer's mixed dentition analysis. Therefore sum of mesiodistal tooth width of lower incisors was computed. And using the formulas the estimated width of lower and upper canine and premolars were calculated.

Sum of lower incisors=23.1 mm. So for lower incisor width of 23.1 mm, following are the values according to Tanaka Johnston and Moyer's mixed dentition analyses.

Tanaka Johnston Analysis: **Table 2**;

Moyer's mixed dentition analysis at 75 percentile: **Table 3**;

Moyer's mixed dentition analysis at 50 percentile: **Table 4**;

Then taking means of these values, we can consider the width of canine for the Bolton's analysis **(Table 5).**

Thereby, using these values for Bolton's analysis, the inter-arch tooth discrepancy could be calculated.

Reliability of this Analysis

As this method is a mathematical calculation and mathematics doesn't need any proof. It's an exact principle, which never changes. Therefore, the reliability need not be necessary but still out of curiosity we have used this analysis in 140 patients with all the teeth present in the arches, and we have calculated the width of canine using this formula. The values were approximately the same as that of the original canine width with a difference of less than 0.5 mm, which proves the reliability of this method and formula.

Indications

- In cases with missing tooth.
- Cases with impacted tooth.
- In cases with gross crowding along with unerupted teeth.

Advantages

- It helps as a guiding path in the estimation of inter-arch discrepancy.
- Has a futuristic view for the malocclusion correction.
- Helps to predict and plan the extraction pattern.
- In case of replacement, gives us the estimated size of tooth to be replaced.

Disadvantages

- Though approximately correct, but exact values are not always necessarily calculated.

Table 2 Tanaka Johnston Analysis.

Arch	Predicted width of canine and premolars (X)	Width of premolars (Y)		Estimated canine width (X-Y)	
		Right	Left	Right	Left
Upper (mm)	22.55	12.5	13	10.05	9.55
Lower (mm)	22.05	13.3	13.3	8.75	8.75

Table 3 Moyer's mixed dentition analysis at 75 percentile.

Arch	Predicted width of canine and premolars at 75 percentile (X)	Width of premolars (Y)		Estimated canine width (X-Y)	
		Right	Left	Right	Left
Upper (mm)	21.3	12.5	13	8.8	8.3
Lower (mm)	21.3	13.3	13.3	8	8

Table 4 Moyer's mixed dentition analysis at 50 percentile.

Arch	Predicted width of canine and premolars at 50 percentile (X)	Width of premolars (Y)		Estimated canine width (X-Y)	
		Right	Left	Right	Left
Upper (mm)	20.6	12.5	13	8.1	7.6
Lower (mm)	20.5	13.3	13.3	7.2	7.2

Table 5 The Bolton's analysis.

Analysis	Upper Right canine (13)	Upper Left canine (23)	Lower right canine (43)	Lower left canine (33)
Tanaka Johnston	10.05	9.55	8.75	8.75
Moyers (75)	8.8	8.3	8	8
Moyer's (50)	8.1	7.6	7.2	7.2
Mean	8.98	8.48	7.98	7.98

Mean was taken for the three analysis, because these analysis were done on different populations, so average of the values will give near approximate values

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