

# Influence of premolar extractions on tooth size discrepancy. Part One: Analysis of Bolton index

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## SUMMARY

The purpose of this study is to determine the influence on four premolar extractions for upper and lower anterior tooth size discrepancy (for total Bolton index (TBI=Overall ratio) and for Bolton value (BV)) and to find out the differences of four first and second premolar extractions tooth size discrepancies (TSD).

148 pretreatment dental casts have been examined. It has been determined that upper teeth of 93 patients suited lower teeth sizes (normal TBI - 91,3%±1,91), 27 patients had upper teeth wider than lower ones (low TBI<89,39%) and 28 patients had wider teeth in lower jaw (high TBI>93,21%).

In this study the influence of four hypothetical first and second premolar extractions (1. all first premolars, 2. all second premolars, 3. upper first and lower second premolars, 4. upper second and lower first premolars) on TSD frequency appearance and size has been estimated.

After performing the analysis it was estimated that in normal Bolton index group TSD is more frequent, when four first premolars are extracted ( $p<0,05$  after comparing with extraction of four second premolars). When TBI is high, in all four hypothetical teeth extraction variations TBI remain increased, which determine 100% TSD. In low TBI group TSD is more usual when four-second premolars are extracted ( $p<0,01$ , after comparing with teeth extractions using 1-st or 3-rd method).

**Key words:** Bolton index, tooth size discrepancy.

## INTRODUCTION

Removal of permanent teeth for orthodontic purpose is still a topical subject. Lots of reasons made it an object of clinical discussion and scientific research. In various periods of 20-th century, in all the treatments permanent teeth were extracted from 6,5% to 80% in all the medical cases (15). The apex of teeth removal was reached in 1968, when teeth extractions was the only solution in 76% of all treatments; it is a lot comparing with 1993 when necessity to extract teeth was applied only up to 28% of all the patients (9). In 10%-50% of all the cases, the first premolars are removed most usually, and only in 15% of all the cases other teeth are removed.

A lot of other studies confirmed TSD influence on bite morphology, function and the results of orthodontic treatment (4,5). According to them, before treatment it is necessary to identify TBI because teeth removal has a direct influence on upper and lower tooth size discrepancy, also on upper and lower incisors position (patients sex and malocclusion do not influence TSD) (3,10,11,12,13). W.A. Bolton stated, that after four premolars were removed, normal TBI value was between 87%-89% (3) when upper teeth sizes suited lower teeth sizes. When teeth are too wide in the upper jaw - TBI is lower than 87% (low TBI) and when teeth are too wide in the lower jaw - TBI value is higher than 89% (high TBI).

The aim of this study is to determine the influence of four premolar extraction variations when TBI is normal, low and high.

## MATERIAL AND METHODS

In the Orthodontic clinic at Kaunas Medical University 148 pretreatment dental casts that fulfill the following criteria have been selected for the study:

1. Teeth 11-16, 21-26, 31-36, 41-46 were fully erupted;
2. Teeth were not affected by significant size or form anomaly;
3. Teeth were intact (no prosthetic restorations, fillings, carious or other hard tissue lesions).

Measurements were made directly on dental casts using "Minchner design Dental Vernier" ("Dentaurum") gauge. Measurements were made in accordance with methodology described by R.C. Wheeler (17). TBI calculated by this formula:

$$TBI = \frac{\sum_{i=31}^{36} dd_i + \sum_{i=41}^{46} dd_i}{\sum_{i=11}^{16} dd_i + \sum_{i=21}^{26} dd_i} * 100 \quad (1)$$

TBI-total Bolton index (Overall ratio);

$dd_i$  -mesiodistal width of each tooth.

Bolton found that the mean overall ratio in patients with no tooth-size discrepancy is 91,3%±1,91. Bolton further stated that after the extraction of four premolars, patients in whom no tooth-size discrepancy existed would have an overall ratio 88%±1. These averages were marked as  $BI_{ideal}$ . When TBI quantity is outside the range 89.0%  $BI_{ideal}$  it means that teeth are wider in the lower jaw. If TBI quantity is less than 87.0%  $BI_{ideal}$

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it means that teeth are wider in the upper jaw. TBI is ideal when the number that is named as Bolton value is subtracted in the first case from the sum of lower jaw teeth width, in the second case - from the sum of upper jaw teeth width. The Bolton value is expressed in millimeters. We can write this from formula (1):

$$BV = \begin{cases} (\sum_{i=31}^{36} dd_i + \sum_{i=41}^{46} dd_i) - const * (\sum_{i=11}^{16} dd_i + \sum_{i=21}^{26} dd_i), & \text{when } TBI > TBI_{ideal} \\ (\sum_{i=11}^{16} dd_i + \sum_{i=21}^{26} dd_i) - \frac{1}{const} * (\sum_{i=31}^{36} dd_i + \sum_{i=41}^{46} dd_i), & \text{when } TBI < TBI_{ideal} \\ 0, & \text{when } -TBI = TBI_{ideal} \end{cases} \quad (2)$$

$dd_i$  - mesiodistal width of each tooth,  $i = 11-16, 21-26, 31-36, 41-46$ ,

$$const = \begin{cases} 0,913 - BV \text{ before extraction,} \\ 0,88 - BV \text{ after extraction} \end{cases}$$

148 analyzed cases according to TBI were divided in three groups:

1. Normal TBI (91,3% 1,91)-93 patients
2. Low TBI (<89,39%) - 27 patients
3. High TBI (>93,21%) - 28 patients

In these groups we assessed the influence of hypothetical first and second premolar extraction variations on TSD frequency effecting changes in appearance and size. These combinations are:

- 1) all first premolars,
- 2) all second premolars,
- 3) upper first and lower second premolars,
- 4) upper second and lower first premolars

In hypothetical cases according to formulas (1, 2) when calculating TBI and BV, extracted teeth widths are equated to zero.

Statistical analysis was performed using SPSS 12.0. The mean ( $\bar{x}$ ) standard deviations (s) were used as descriptive

values. In comparing multiple measurement averages one way analysis of variance was employed. Student's t-tests were used to compare the results and variation coefficient. McNemar's test was used to compare the equality of proportions in two dependent samples. Level of significance was chosen 0,05. Three independent investigators performed all measurements on dental casts. No statistically significant intra-individual ( $p < 0,01$ ) and inter-individual ( $p < 0,05$ ) differences of the measurements were found.

### RESULTS AND DISCUSSION

After assessing the influence on TBI changes in 16 possible cases of four hypothetical premolar extraction values essential differences between analyzed normal, low and high TBI groups were found. In hypothetical teeth extractions if TBI was normal (88% 1) we named this effect positive (P), if TBI after extraction was smaller or larger than 88% 1, we named this effect negative (N) (10) (Table 1).

When TBI is normal, despite the extraction choice made, in 38,7% (36 patients) of all the cases the undesirable effect is inevitable, TBI becomes smaller or larger than 88% 1 (Table 1). TBI is normal, after choosing any of the extraction choice in 9,7% (9 patients) of the all cases, but in 51,6% (48 patients) cases, the choice of the proper individual variation (only one or one from two/three) helps to evade TSD problems (Table 1). There wasn't a single case, in which after four first premolar extractions TSD didn't occur, but in other three variations there was, and there wasn't a single case in which TSD would occur after extracting four first premolars or four-second premolars, but it occurred in other two variations.

In low TBI group, despite of the chosen extraction type in 33,3% (9 patients) cases TBI becomes smaller or larger than 88% 1. Only the choice of the most effective variant helps to

**Table 1.** Changes of TBI (positive (P), negative (N) effect) distribution in normal, low and high Bolton index groups after hypothetical extractions

Situation type	TBI changes (effects) in hypothetical variants				Research cases					
	Low TBI		High TBI		Normal TBI		High TBI			
	14 24	15 25	14 24	15 25	n	%	n	%	n	%
	44 34	45 35	45 35	44 34						
1	N	N	N	N	9	33,3	36	38,7	28	100,0
2	N	N	N	P	1	3,7	5	5,4	0	0,0
3	N	N	P	N	4	14,8	1	1,1	0	0,0
4	N	N	P	P	0	0,0	2	2,2	0	0,0
5	N	P	N	N	0	0,0	3	3,2	0	0,0
6	N	P	N	P	0	0,0	6	6,5	0	0,0
7	N	P	P	N	1	3,7	4	4,3	0	0,0
8	N	P	P	P	0	0,0	8	8,6	0	0,0
9	P	N	N	N	1	3,7	0	0,0	0	0,0
10	P	N	N	P	3	11,1	2	2,2	0	0,0
11	P	N	P	N	6	22,2	4	4,3	0	0,0
12	P	N	P	P	1	3,7	1	1,1	0	0,0
13	P	P	N	N	0	0,0	0	0,0	0	0,0
14	P	P	N	P	1	3,7	4	4,3	0	0,0
15	P	P	P	N	0	0,0	8	8,6	0	0,0
16	P	P	P	P	0	0,0	9	9,7	0	0,0
Total:					27	100,0	93	100,0	28	100,0

Effect of teeth extraction named positive (P), when TBI is  $88\% \pm 1$ . Effect negative (N)- when after extraction TBI is lower or bigger than  $88\% \pm 1$ .

**Table 2.** Frequency of tooth size discrepancy created by removal of different combinations of premolars in low and normal TBI groups

Cases No.	Combinations of premolar extractions	Frequency of tooth size discrepancy in the groups			
		Low TBI, n=27		Normal TBI, n=93	
		Number of cases	%	Number of cases	%
1	14 24	15	55.6	65	69.9
	44 34				
2	15 25	25	92.6	51	54.8
	45 35				
3	14 24	15	55.6	56	60.2
	45 35				
4	15 25	21	77.8	56	60.2
	44 34				

correct TSD in 66,7% (18 patients) of all the cases (Table 1).

The research showed that in high TBI group in 100% of all the cases (28 patients) TSD remains the same or even gets worse (Table 1).

Before any extraction it is necessary to calculate possible TBI changes in every single case because of high data dispersal.

Researching the influence of each of four hypothetical extraction variations on frequency changes normal and high TBI groups were analyzed, because in the previous part of this study it has been ascertained that to analyze it in high TBI group is inexpedient.

Also after performed calculations differences between normal and low TBI groups were found. While TBI is normal, TSD appeared in 69,9% (65 patients) of all cases, after four first premolar extractions and after extracting second premolars TSD appeared in 54,8% (51 patients) of all the cases. After extracting first premolars in upper jaw and second premolars in lower jaw, as well as extracting second premolars in upper jaw and first premolars in lower jaw, TSD occurred with equal frequency - 60,2% (56 patients) of all the cases (Table 2).

In low TBI group TSD usually occurred after extracting four second premolars - 92,6% (25 patients) of all the cases. In the same TBI group after extracting two upper second and two

lower first premolars TSD occurred in 77,8% (21 patients) of all the cases. Just in 55,6% (15 patients) of cases of this group TSD occurred after extracting four first premolars or after extracting two upper first and two lower second premolars (Table 1). It is noteworthy that in both groups the extraction of second premolars has the biggest influence on TSD but with opposite results.

## CONCLUSIONS

The obtained data allows us to state that it is necessary to calculate TBI before

extraction of the premolars, because any accidentally chosen type of extraction has bigger than 50% risk of causing TSD. While TBI is low it is advisable to calculate and choose the most suitable way of teeth removal, and while TSD is normal it is necessary to choose the extraction that would cause less harm.

1. When TBI is low, i.e. while bigger teeth are in the upper jaw, the situation may change for the better in 66,7% of the cases, just because of the properly chosen way of removal. It is advisable to remove four first premolars or first two upper and second two lower premolars, because these ways of extraction cause TSD rarest of all (55,6%). After teeth removal TSD tends to be better in clinical way.

2. When TBI is normal it has been determined that situation is getting worse in 38,7% of all the cases and remains the same in 9,7% of all the cases despite the chosen way of removal, or 51,6% of the cases when the proper way is chosen. Rarely, in 54,8% of the cases, the situation is corrected when extracting second premolars and most often (in 69,9% of the cases) TSD occurs after four first premolars have been extracted.

3. When TBI is high, i.e. while bigger teeth are in the lower jaw, teeth removal never changes the situation for the better.

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