

TOOTH SIZE DISCREPANCIES AND DENTAL ARCH WIDTH IN PATIENTS WITH PALATALLY AND LABIALLY IMPACTED MAXILLARY CANINES

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and transversal width in patients with unilateral palatally and labially canine impaction were found.

Summary

It has been reported that labial displacement of the upper permanent canine is most frequently associated with crowding and constriction of the dental arch, but palatally impacted canines have sufficient space to erupt and are associated with a reduction of teeth width.

Aim. To compare the Bolton ratios, individual tooth and dental arch widths in patients with unilateral palatally and labially impacted canines.

Methods. The study sample consisted of 75 patients with unilaterally impacted maxillary canines (palatal impaction group n=48 (64%), labial impaction group n=27 (36%)). Teeth width, upper dental arch width and form analysis was performed on the pre-treatment dental casts. Bolton's ratio was calculated.

Results. There were no differences in tooth widths between palatal and labial impaction groups, (except central incisors that were significantly smaller on the impaction side in both groups). No statistical relation between impacted tooth position on labio-palatal direction and meaning of the Bolton's ratio was found. 54.66 % of patients had normal anterior Bolton's ratio and 53.33%- normal overall Bolton's ratio. The distance between upper first molars and first premolars does not differ in both impaction groups. No statistical correlation was found between the upper dental arch form and impacted canine position in labio-palatal direction.

Conclusion. Central incisors were significantly smaller on the impaction side of the dental arch in both palatally and labially impaction groups. No differences in the Bolton ratios, dental arch form

Introduction

Most canine eruption anomalies diverge from the normal eruptive site in either of two directions: palatal or labial. It has been reported that the prevalence of palatally impacted canines (**PIC**) is by an almost sixfold greater than labially impacted canines (**LIC**) [1]. Both genetic and local factors have been shown to be intimately associated with eruption disturbances of the maxillary canine [2].

According to the etiology and related occlusal features, PIC and LIC is considered to be different diagnoses. Most PIC cases are characterized as being nonextraction cases [1,3], because the teeth of such patients appear smaller than average [4-7] and dental arches are broader than in other patients [8]. Whereas general opinion is that LIC is more commonly related to insufficient arch length and associated with crowding [9].

Tooth size and dental arch dimensions are determining factors in dental crowding. Besides tooth crowding could be conditioned not only by tooth size-dental arch size disproportion, but also by inter-arch tooth size discrepancies, which are described as Bolton ratio. Bolton analysis is the widely used method for measuring tooth size discrepancies, especially in the anterior region of the dental arch, where relative tooth sizes control the amount of overbite, overjet, crowding and spacing. According to Proffit approximately 5% of the population has a significant tooth size discrepancy because of disproportion in size of the upper and lower teeth [10]. Anomalies in upper lateral incisors are the most common cause of such disproportion, but variation in premolar and other teeth also present. Al-Nimri *et al.* evaluating Bolton ratio in female patients concluded that patients with unilateral PIC do not have more inter-arch tooth size discrepancies than patients without PIC [11].

Our study aim was to compare the Bolton ratio individual tooth and dental arch widths in patients with unilateral PIC and LIC.

Material and Methods

The material consisted of the pre-treatment dental casts of 75 (59 female and 16 male) patients with unilateral impacted maxillary canine. The patients for this study were selected from the Orthodontic Clinic, Lithuanian University of Health Sciences according to the following criteria:

- a) Non-syndromic patients with unilaterally impacted upper permanent canine (non-erupted after complete root development or if the contra-lateral tooth was erupted for at least 6 months with complete root formation [12],
- b) No previous orthodontic treatment,
- c) No teeth loss or agenesis that may affect the occlusion.

In 48 (64%) of cases canine was impacted in palatal position, in 27 (36%) in labial position.

Examination included:

- *Tooth width analysis.* The widths (greatest mesio-distal diameter from the anatomic mesial contact point to the anatomic distal contact point parallel to the incisal surfaces of the teeth) of all teeth were calculated and compared between impaction and non-impaction sides. The mesio-distal diameter of the impacted canine was measured on the casts taken at the end of orthodontic treatment.

- *Bolton's analysis.* The proportionality of both dental arches was measured according to the Bolton analysis and compared Bolton's mean ratios: ratio for 12 teeth: 91.3 ± 1.91 ($\pm 2SD$); and ratio for 6 teeth: 77.2 ± 1.65 ($\pm 2SD$) [13-14].

- *Dental arch width analysis.* The arch width between upper first premolars measured with the calliper tips placed into the deepest portion of the central fossae of the upper first premolars at their junctions with the most lingual aspect of the buccal cusp. The arch width between upper first molars measured by placing the calliper tips into the deepest portion of the midline of the inter-cuspal fissures.

- *The upper dental arch form* was evaluated according to the upper dental arch model by overlying transparent sheet with dental arch form template [15]:

- a) Oval
- b) Tapered
- c) Square.

All dental cast measurements were made by the same examiner (RS) using sliding caliper (Dentaurum, Germany) to 0.1mm. Errors in measurement were analyzed by measuring randomly selected 20 dental casts for the second

time by the same caliper in an interval of 10 days. Paired t test was done to the first and second measurement. No significant differences found, so concluded that the measurement was reliable.

Statistical analysis. The SPSS (version 17.0) computer program was used for the statistical analyses. The differences between the impaction and non-impaction upper dental arch sides were determined using a chi-square test and a Student's t-test. P values less than 0.05 were considered significant.

Results

Teeth width analysis. There were no differences in tooth widths between PIC and LIC groups; however central incisors were significantly smaller on the impaction side of the dental arch (Table 1).

Bolton's analysis

The average anterior Bolton's ratio for PIC group was 78.74 ± 3.3 and for LIC group- 78.36 ± 3.3 ($p > 0.05$). The average overall Bolton's ratio for PIC group was 89.89 ± 3.82 and for LIC group- 90.64 ± 3.82 ($p > 0.05$). No statistical relation between impacted tooth position in the labio-palatal direction and meaning of the Bolton's ratio was found. All the data presented in Table 2.

Dental arch width analysis. No statistical relation was found between impacted tooth position in the labio-palatal direction and the distance between upper first premolars and first molars. All the data are present in Table 3.

Upper dental arch form analysis

Tapered upper dental arch form was found in 29 cases (60.4%) in PIC and 19 cases (70.37%) in LIC. Oval arch form was found in 15 cases (31.3%) in PIC and 8 cases (29.62%) in LIC. Square dental arch form was only in 4 cases (8.3%) in PIC group. No statistical correlation was found between the upper dental arch form and impacted canine position in labio-palatal direction.

Discussion

The purpose of this study was to compare the individual tooth widths, Bolton ratios and dental arch widths in patients with unilateral PIC and LIC.

Results of our study showed no significant difference in the mesiodistal widths of the maxillary teeth between impaction and non-impaction sides, except central incisors that were statistically significantly smaller on the impaction side of the dental arch in both groups. Although lateral incisors were smaller on the impaction side in PIC group, this difference was not statistically significant.

Distal root surface of the maxillary lateral incisor is important in guiding the maxillary canine into the arch during

Table 1. Comparison of the mesio-distal dimensions (in millimeters) of the maxillary tooth widths on the impaction and non-impaction sides.

PIC group						LIC group					
Tooth	Impaction/non-impaction side	Mean	n	SD	p	Tooth	Impaction/non-impaction side	Mean	n	SD	p
Second premolar	Impaction	7.16	48	0.54	p>0.05	Second premolar	Impaction	7.24	27	0.63	p>0.05
	Non-impaction	7.17	48	0.45			Non-impaction	7.11	27	0.52	
First premolar	Impaction	7.34	48	0.53	p> 0.05	First premolar	Impaction side	7.22	27	0.54	p>0.05
	Non-impaction	7.26	48	0.59			Non-impaction	7.26	27	0.56	
Canine	Impaction	8.20	48	0.62	p> 0.05	Canine	Impaction	8.09	27	0.62	p>0.05
	Non-impaction	8.15	48	0.89			Non-impaction	8.02	27	0.71	
Lateral incisor	Impaction	7.39	48	1.08	p> 0.05	Lateral incisor	Impaction	7.20	27	0.70	p>0.05
	Non-impaction	7.53	48	0.79			Non-impaction	7.28	27	0.81	
Central incisor	Impaction	9.27	48	0.52	p< 0.05	Central incisor	Impaction	9.30	27	0.52	p<0.05
	Non-impaction	9.08	48	0.55			Non-impaction	8.98	27	0.58	

Table 2. Bolton's ratio for 12 and 6 teeth ($\pm 2SD$).

Bolton's ratio for 12 teeth	The position of impacted canine		Bolton's ratio for 6 teeth	The position of impacted canine	
	PIC	LIC		PIC	LIC
<87.48 \pm 3.82	10 (20.8%)	4 (14.8%)	<73.9 \pm 3.3	7 (14.6%)	3 (11.1%)
91.3 \pm 3.82	29 (60.4%)	17 (63.0%)	77.2 \pm 3.3	26 (54.2%)	15 (55.6%)
>95.12 \pm 3.82	9 (18.8%)	6 (22.22%)	>80.5 \pm 3.3	15 (31.3%)	9 (33.3%)
<i>Total:</i>	48 (100%)	27 (100%)	<i>Total:</i>	48 (100%)	27 (100%)

Table 3. Distances between upper first premolars and first molars depending on the impacted canine position (p>0.05).

Impacted canine position	Distance between premolars mm (SD)	Distance between molars mm (SD)
PIC	34.36mm (2.94)	44.38mm (3.38)
LIC	34.83mm (3.37)	44.17mm (5.03)

eruption [16], therefore when the lateral incisor is small or absent there is a predisposition to the canine impaction [4,8]. Smaller lateral incisor in cases of PIC was recorded in many studies [4,6,17]. Langberg and Peck have shown that not only upper lateral, but also central incisors are smaller in PIC cases than in controls [5]. However Becker *et al.* stated that although there is a trend to mesio-distal narrower teeth in PIC patients, this difference reached statistical significance only for maxillary first premolars and molars in males and for central and lateral incisors in females [7]. Anic-Milosevic *et al.* stated that the only difference is a buco-lingual dimension for the central and lateral incisors which are significantly smaller on the impaction side of the dental arch in females [17]. Al-Nimri *et al.* and Brenchley and Oliver [8,18] found no evidence to support

the view that PIC is associated with diminutive maxillary teeth.

We found no relation between tooth widths and impacted tooth position in the labio-palatal direction. Only lateral incisors were smaller on the impaction side in PIC group, though this difference was not statistically significant. This is in disagreement with results of other studies. Artmann *et al.* found that the widths of the lateral incisors in cases with LIC were on average 0.65mm broader than in cases with PIC [19]. Chaushu *et al.* noted that LIC is associated with larger dimensions of the maxillary incisors than PIC [2,20]. In females it is due to larger-than-normal teeth in the LIC group and normally-sized teeth in the PIC group, whereas in the males-due to the normally-sized teeth in LIC group and the smaller-than normal teeth in PIC group.

No statistical relation between impacted tooth position in the labio-palatal direction and meaning of the Bolton's ratio was found. Al-Nimri *et al.* and Al-Khateeba *et al.* also did not find significant differences with regard to Bolton ratios between PIC patients and control group [6,11]. Bolton suggested that a ratio greater than 1SD from his reported mean values indicates a diagnostic consideration [14]. Other authors suggested that values inside 2SD of the Bolton's mean ratio have been clinically accepted for de-

termining tooth size discrepancy [21]. The prevalence of Bolton's tooth-size discrepancies in the general population has been quoted as being 5% (6). However, many scientists showed completely different results, where approximately 22-28% of subjects have a significant deviation from Bolton's anterior ratio mean [22-23]. In the present study it was established that patients with impacted canines have even bigger deviation from the standart Bolton's ratio: only 54.66% of all patients had normal anterior Bolton's ratio. Overall Bolton's ratio was in normal limits in 53.33% of cases.

The distance between upper first molars and first premolars does not differ in both PIC and LIC groups. We did not find studies where the maxillary transverse arch width between PIC and LIC patients could be comparing. In many studies maxillary transverse arch width in patients with PIC or LIC comparing with the arch width in controls. Regarding PIC, results of researches are conflicting. Some authors confirm that where is no deficiency in either anterior or posterior maxillary transverse arch width in patients with PIC [17,24]. Stellzig *et al.* found arch length sufficiency in 82% of subjects with a PIC [25]. Al-Nimri *et al.* found that the upper arch is even significantly broader in patients with PIC than in other patients [8]. Though Al-Khateeba *et al.* studying scanned dental casts concluded the total maxillary width in the PIC patients exhibit smaller dimensions than in the controls [6]. McConnell concluded that subjects with PIC demonstrate profound transverse maxillary deficiency located in the anterior portion of the dental arch [26]. Saiar *et al.* stated that the maxillary inter-canine alveolar arch width is not a good predictor to determine the anomaly of canine impaction [27].

While general opinion is that LIC is related to the constriction of the dental arch, Kafle *et al.*, in accordance to our results, found any statistical difference between inter-premolar and inter-molar arch width in LIC patients and control group [28]. Mucedero *et al.* shows that LIC subjects have reduced maxillary inter-canine width, however no significant differences were assessed for the comparisons of maxillary inter-molar width on the LIC group when compared with the control group [9]. Larsen concluded that in patients with ectopic (palatal/labial) maxillary canines the maxillary complex is shorter sagittally as well as vertically, while it is wider transversally [29].

Another feature related to maxillary transverse arch width is the upper dental arch form. No statistical correlation was found between the upper dental arch form and impacted canine position in labio-palatal direction. In the study by McConnell *et al.* also no significant difference in the arch form between the canine impaction group and non-

impacted subjects was found [26]. Comparing upper dental arch forms we found that ~60% of patients with PIC and ~70% of patients with LIC impaction had tapered dental arch form. Olmez and Dogan [30] evaluating the dental arch forms on the non-impaction patients concluded that the most frequent dental arch form is tapered (62.5%) followed by the ovoid (27.3%) and the square one (10.2%). The present study results (tapered form 65.38%, ovoid-30.46% and square-4.15%) matched with Olmez and Dogan data. Similarly, Oliver *et al.* in his study found that both Caucasian and oriental patients groups have a higher incidence of tapered dental arch forms (4). It is believed that dental arch form is more determined by ethnical groups, rather than individual local factors: the most usual dental arch form in Caucasian patients is tapered, in Japanese-square [15].

Summarising the results of our study, no differences in the Bolton ratios, dental arch widths and forms in patients with unilateral PIC and LIC were found. It is possible to simulate that canine impaction probably is not determined by a single factor, but is affected by several factors influence. Differences in the incidence of dental crowding in PIC and LIC patients does not depend on the teeth or dental arch widths. This is more likely to be concerned with other features of malocclusion. PIC is frequently related to Class II-2 malocclusion [8,16,31,34]. Bishara, Leifert and Jonas demonstrated that the prevalence of Class II-2 malocclusion and deep overbite in patients with impacted canines is higher than in the general population [33,34]. Ludicke *et al.* [16] found that patients with symptoms of Class II-2 malocclusion should be regarded as a risk group for canine impaction. Whereas LIC did not demonstrate significant associations with any specific craniofacial pattern in the sagittal plane [9] or is more often related to Class I and Class III malocclusion [28]. Other studies showed that LIC is significantly associated with hyperdivergent vertical skeletal relationships [9].

Conclusion

1. Central incisors were significantly smaller on the impaction side of the dental arch in both palatally and labially impaction groups.

2. No differences in the Bolton ratios, dental arch form and width in patients with unilateral PIC and LIC were found.

The authors state no conflict of interest

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**DANTŲ DYDŽIO IR DANTŲ LANKO PLOČIO
SKIRTUMAI ESANT GOMURINEI IR LŪPINEI
VIRŠUTINIO ŽANDIKAULIO NUOLATINIO ILTINIO
DANTIES RETENCIJAI**

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Raktažodžiai: retinuotas iltinis dantis, Boltono indeksas, dantų vainiko plotis.

Santrauka

Manoma, kad viršutinio nuolatinio iltinio danties retencija lūpinėje padėtyje yra susijusi su dantų lanko susiaurėjimu ir dantų susigrūdimu, o gomuryje retinuotas iltinis dantis dažniausiai susijęs su pakankama vieta jam išdygti ir dantų dydžio sumažėjimu.

Tikslas. Palyginti dantų bei dantų lankų pločius ir Boltono santykį pacientams su vienpuse lūpine arba gomurine nuolatinio iltinio danties retencija.

Tyrimo medžiaga ir metodai. Tyrimo imtį sudarė 75 pacientai su vienpuse viršutinio žandikaulio nuolatinio iltinio danties retencija (gomurinės retencijos grupė $n = 48$ (64 %), lūpinės retencijos grupė $n = 27$ (36 %). Atskirų dantų mediodistalinis plotis, viršutinio dantų lanko transversalinis plotis tarp pirmųjų prieškrūminių ir krūminių dantų ir forma matuoti pagal gipsinius dantų lankų modelius, apskaičiuotas Boltono indeksas.

Rezultatai. Centriniai kandžiai buvo mažesni abiejų grupių retencijos pusėse. Nepastebėta statistiškai reikšmingo skirtumo tarp kitų dantų pločių esant lūpinei arba gomurinei iltinio danties retencijai. Taip pat nebuvo rasta jokio statistinio ryšio tarp retinuoto

iltinio danties padėties lūpine -gomurine kryptimi ir Boltono reikšmės. Priekinių dantų Boltono indekso matavimas atitiko normą 54,66 % atvejų, visų dantų Boltono indekso matavimas – 53,33% atvejų. Atstumas tarp viršutinių pirmųjų krūminių dantų ir pirmųjų prieškrūminių dantų nesiskyrė abiejose grupėse. Nerasta statistinio skirtumo tarp viršutinio dantų lanko formos ir retinuoto iltinio danties padėties lūpine - gomurine kryptimi. 65,39% pacientų nustatyta smailėjanti dantų lanko forma.

Išvados. Abiejose grupėse (lūpinėje ir gomurinėje) dantų lanko retencijos pusėje centriniai kandžiai buvo statistiškai mažesni. Nerasta ryšio tarp vienpusės lūpinės arba gomurinės iltinio danties retencijos ir Boltono indekso reikšmės, dantų lanko formos ir transversalinio dantų lanko pločio.

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