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Morphometric study of length and grooves of lower central incisors roots

Estudo morfométrico das concavidades proximais e do comprimento radicular dos incisivos centrais inferiores em humanos

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anatomy/morphology; tooth root; periodontitis; root concavities; periodontal attachment loss.

Abstract

Introduction: Root grooves are considered a risk factor for periodontal disease. The purpose of this study was to measure the length of the root of lower central incisors (LCI), as well as the width and depth of the concavities of their proximal surfaces. **Material and methods:** The width and depth of root concavities, as well as root length, were evaluated in 90 LCI. All teeth were measured using a digital contour measuring instrument (Contracer®) for the root grooves and a digital calliper for evaluating root length. **Results:** After statistical analysis (t-Student and Kruskal-Wallis Anova tests, $p<0.05$) it was possible to confirm: the mean root length on its distal surface (13.88 ±1.47 mm) and on its mesial surface (13.76±1.50 mm). Concavities were present

in 100% of the samples; concavities were found 2 mm, coronally from the CEJ, at the CEJ, and at all root surface. The concavities were wider than deeper; on the mesial surface, the greatest width was 1.877 mm and the greatest depth was 0.135 mm; on the distal surface the greatest width was 1.717 mm and the greatest depth was 0.118 mm. **Conclusion:** The distal surface of the lower central incisor is the longest. The root concavities on the proximal surfaces are present in 100%; the greatest width and depth was at 6 mm apically from the CEJ at both sides, which corresponds to the root middle third. One must get acquainted to the morphological variations of roots to enhance diagnosis, prognosis and treatment.

Resumo

Introdução e objetivo: Concavidades radiculares são tidas como fator de risco de doenças periodontais. Esta investigação foi realizada com o objetivo de estudar as concavidades radiculares proximais (largura e profundidade) e o comprimento radicular do incisivo central inferior (ICI). **Material e métodos:** A largura e a profundidade das concavidades radiculares, assim como o comprimento radicular, foram avaliadas em 90 ICI. Todos os dentes foram medidos por aparelho Contracer® computadorizado para as concavidades radiculares, enquanto os comprimentos radiculares foram medidos por meio de um paquímetro digital. **Resultados:** Após análise estatística (testes t de Student e Kruskal-Wallis Anova), foi possível confirmar a média dos comprimentos radiculares em sua superfície distal (13,88±1,47 mm) e mesial (13,76±1,50 mm). As concavidades estavam presentes em 100% da amostragem; foram encontradas concavidades 2 mm coronariamente à JEC, na JEC e também em toda a superfície radicular. As concavidades tinham maior largura do que profundidade; na superfície mesial, as maiores medidas de largura e profundidade foram 1,877 mm e 0,135 mm, enquanto na superfície distal foram 1,717 mm e 0,188 mm. **Conclusão:** A superfície distal do ICI é a mais longa. As concavidades estão presentes em todos os ICIs; a maior largura e profundidade foi de 6 mm apicalmente à JEC em ambos os lados, correspondendo ao médio da raiz. É preciso, portanto, conhecer as variações morfológicas de raízes para melhores diagnósticos, prognósticos e tratamentos.

Palavras-chave: anatomia/morfologia; raiz dentária; periodontite; cavidades radiculares; perda de inserção periodontal.

Introduction

Some anatomical conditions can promote plaque retention, making difficult its removal and facilitating incidence of periodontal lesions [1]. Therefore, the tooth anatomy can play an important role in the periodontal disease etiology, acting as a predisposing factor [10]. Several anatomical root characteristics have been studied and related to the diagnosis, prognosis and treatment of periodontal disease [8]. Within these morphological changes we can mention the cervical enamel projections [2, 10, 12, 14], the palatal radicular groove [6, 18], the enamel pearls [5], the cervical enamel projections [11] and the root concavities. These were studied in superior and inferior first molars [4], superior first molars [9], inferior first molars [8]; superior first pre-molars [3], inferior canines [15], superior lateral incisors [18] and superior and inferior first and second molars [14].

Fox and Bosworth (1987) [7], as well as Ong and Neo (1990) [13], measured the width and extension of proximal concavities in several groups of teeth. They found that concavities are present in most human teeth, a fact that can complicate periodontal therapy, as well as repair dentistry, if ignored.

This study aims to evaluate morphometrically the presence of root concavities in the lower central incisors, enhancing the knowledge of the tooth root morphology to result in a correct instrumentation and posterior success in the periodontal treatment.

Material and methods

Ninety lower central incisors were selected from a tooth bank. This study was approved by the University of São Paulo, School of Dentistry, Ethics Committee (number 95/99).

Root length was measured using a digital caliper (Mitutoyo – Absolute Digimatic NTD12-15C. Kanagawa, Japan). The analyses were observed 2 mm coronally from CEJ, at CEJ and each 2 mm apically up to the root apex. The CEJ was used as a reference for measurements in the corono-apical direction. Measurements of each root surface were performed three times in order to guarantee an accurate measurement. Calibration of the examiner was important to evaluate reproducibility during measurement procedures.

The measurements of concavities present on proximal surfaces in a buccal-lingual direction and in a mesio-distal direction were obtained with a digital contour profile measuring instrument Contracer® (Model cv500, x-axis resolution: 0.050 μm; z-axis resolution: 0.20 μm. Kanagawa, Japan), according to previous study [18].

This instrument makes a graph of the profile of an area, allowing the measurement of width and depth of concavities or grooves in the surfaces analyzed without the need for serial root cutting.

Numerical values for the width and depth of concavities were calculated using software (Mitutoyo – Formpack-1000. Kanagawa, Japan) which precisely allows the union of the most convex points, obtaining the width (x-axis) and the determination of the most concave point to the final reading of the depth (z-axis) for each level (figure 1).

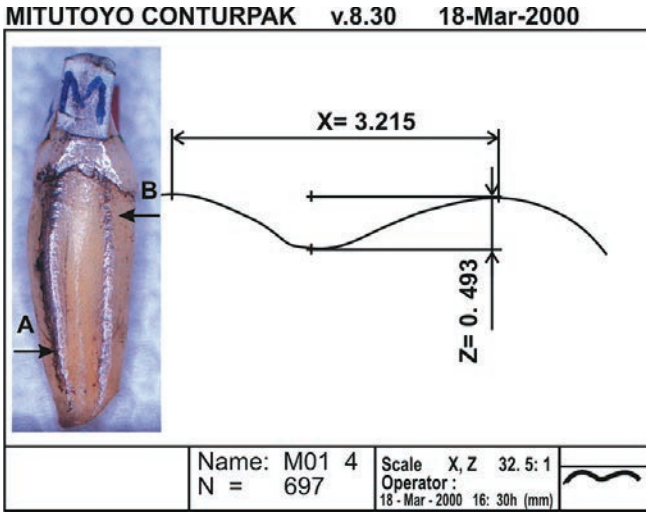

Figure 1 — Delimitations with graphite (A e B); width (X) and depth (Z)

Results

The variance analysis test was performed in order to verify if there were differences in the measurements of root length among the four surfaces (mesial, distal, lingual and buccal). It was verified, using Tukey's multiple comparison test, that root length on its mesial surface is statistically greater when compared to that on its distal, buccal and lingual surfaces (table I). According to table 1 we can conclude that there is no statistical significant difference (t=0.685) between root lengths of distal and mesial surfaces. Concerning the prevalence of concavities in proximal surfaces, there are concavities in all proximal surfaces of analyzed teeth. Tables II and III demonstrate the medial of the distal and mesial concavities widths. At table IV and V we observe the medial of the distal and mesial depths.

Table I — Root length obtained (in mm) of lower central incisors (distal and medial surfaces) through t-Student test

	Root length	
Parameters	**Distal**	**Mesial**
N	90	90
Mean	13.88	13.76
Median	13.87	13.54
Standard deviation	1.47	1.50

F = 0.166; p = 0.685

Table II — Width buccal-lingual of concavity of lower central incisor (distal)

	Distal width (mm)						
Parameters	Position						
	0	**1**	**2**	**3**	**4**	**5**	**6**
N	90	90	90	90	90	90	80
Mean	0.841	0.684	0.960	1.619	1.717	1.224	0.604
Median	0.350	0.000	0.210	1.702	1.825	1.301	0.000
Standard deviation	0.969	0.918	1.174	1.215	1.091	1.032	0.766
H calculate = 74.31			H critic = 12.59				

Table III — Values for the mesial width of concavity

	Mesial width (mm)						
Parameters	Position						
	0	**1**	**2**	**3**	**4**	**5**	**6**
N	90	90	90	90	90	90	79
Mean	0.643	0.481	0.991	1.844	1.877	1.525	0.720
Median	0.000	0.000	0.000	1.977	2.111	1.683	0.000
Standard deviation	0.940	0.808	1.176	1.121	1.084	0.983	0.885
H calculate = 141.50				H critic = 12.59			

Table IV — Values for the distal depth of concavity

	Distal depth (mm)						
Parameters	Position						
	0	**1**	**2**	**3**	**4**	**5**	**6**
N	90	90	90	90	90	90	79
Mean	0.034	0.028	0.050	0.105	0.118	0.074	0.031
Median	0.013	0.000	0.004	0.053	0.086	0.039	0.000
Standard deviation	0.063	0.044	0.089	0.130	0.127	0.094	0.055
H calculate = 66.70			H critic = 12.59				

Table V — Values for the mesial depth of concavity

	Mesial depth (mm)						
Parameters				**Position**			
	0	**1**	**2**	**3**	**4**	**5**	**6**
N	90	90	90	90	90	90	79
Mean	0.040	0.026	0.049	0.119	0.135	0.094	0.051
Median	0.000	0.000	0.000	0.072	0.085	0.062	0.000
Standard deviation	0.119	0.092	0.088	0.126	0.130	0.100	0.123
H calculate = 111.12			H critic = 12.59				

The localization and the measurements of widths and depths (mesial and distal) followed by the respective root lengths are illustrated at figure 2.

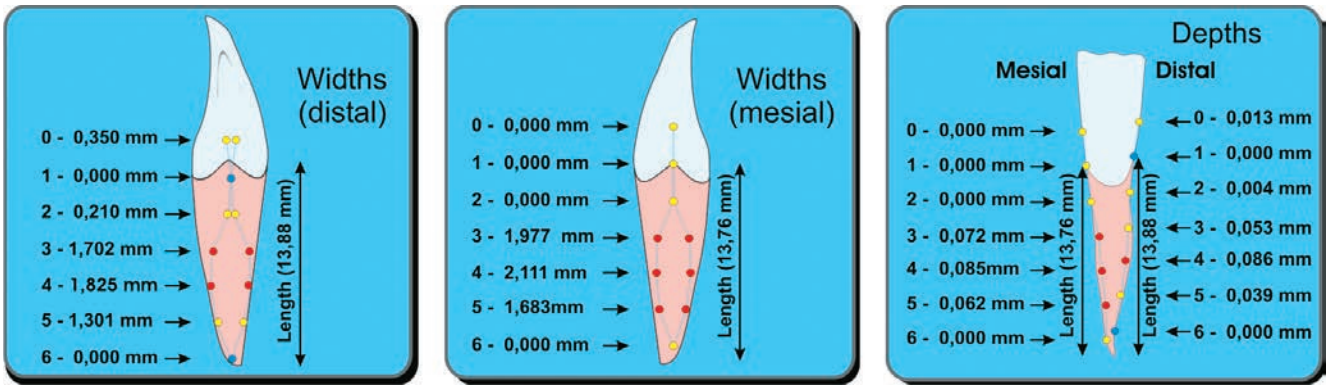

Figure 2 — Pictures of localization and measurements of width and depth of distal and mesial concavities

Discussion

It was not possible to find in literature any detailed description and evidence based study concerning lower incisors' root concavities and length.

The concavities profile using the Contracer® (Model cv500, x-axix resolution: 0.050 μm; z-axis resolution: 0.20 μm. Kanagawa, Japan) has as main advantages, if compared to previous methods, the precision and the lack of need of serial root cutting, according to others studies [13, 15, 18].

Booker & Loughlin (1985) [3], Fox & Bosworth (1987) [7], Roussa (1998) [14], Sanchez & Pustiglioni (1998) [15], Storrer et al. (2006) [18] concluded the importance of concavities in order to enhance the diagnosis, periodontal treatment and prognosis, as well as reparative dentistry.

Leknes (1997) [10] published a literature review about the importance of the influence of anatomic and iatrogenic and root surfaces characteristics on bacterial colonization and periodontal destruction.

As the periodontal disease develops, the root surface is exposed, disclosing anatomical details which were previously covered by periodontal tissues. These details are not significant in a healthy periodontal tissue; nevertheless, they can contribute to the exasperation of the existent periodontitis [16].

According to Smukler (1989) [17], only interproximal tooth brushes can access proximal root surfaces concavities; special dental flosses are able to clean concavities with moderate depth. On the other hand, the ordinary dental floss appears to reach only plain and convex surfaces.

Pustiglioni & Romito (1999) [19] analyzed the influence of these anatomical variations in the loss of attachment detected in sites with periodontal disease. The data of this study does not evidence statistical relation between loss of attachment and the presence of root concavities. However, the authors emphasize that anatomical variations cannot be underestimated during clinical examination, diagnosis, prognosis, surgical treatment and at periodontal maintenance period.

Complementary exams as tridimensional topographic images (cone-beam) can aid the measurement of periodontal bone defect depth as well as the visualization of the concavities bellow the CEJ [12], avoiding future periodontal attachment loss.

In the present study, there were root concavities in 100% of the sample. Moreover, Ong & Neo (1990) [13] analyzed Chinese extracted teeth and observed that lower incisors had concavities at distal (73%) and mesial (93%) surface. However, the authors state that "there was difference in the proximal root anatomical characteristics of the teeth of this population when compared with other ethnical groups". In this study, the concavities were usually wider and deeper at the distal compared to mesial surface. The mean root length of the lower incisor at the distal surface was13.76 ± 1.50 mm and there was concavities at 100% of the sample.

The deeper and wider concavities were found 6.0 mm apically to the CEJ, corresponding also to the half third of these teeth. In most of the situations, at the level 4 mm apical to the CEJ, we are in the beginning of a concavities area to both surfaces of the lower incisors, even if it is not possible to detect them with the periodontal probe.

According to Fox & Bosworth (1987) [7], concavities are common characteristics of the root

surfaces of human teeth present in 100% distal surface of the lower anterior teeth.

The literature demonstrates a tendency to the proximal concavities being deeper and wider at the root half third region.

The lower incisors concavities are usually wider and shallow than deep. This can aid the proximal periodontal defect treatment through root scaling. However, we observe that 6 mm apical to the CEJ, there were higher medians in width of concavity (1.825 mm to distal and 2.111 mm to mesial) as well as in depth (0.086 mm to distal and 0.085 mm to mesial). Consequently, it is important for the clinic to remember, in his daily routine, that this is a critical area. The tendency according to our results is that from the 6 mm point, following to the root apex and coronally, the concavities decrease in width as well as in depth, almost disappearing.

These findings are in agreement with Fox & Bosworth (1987) [7], who state that the presence of proximal concavities is extremely common at the first 5 mm apical to the CEJ.

A gold standard method for measuring the root length is not blatant in literature. Our length results on the distal surface was 13.88 ±1.4mm and on the mesial surface 13.76±1.50mm. A digital caliper was used to obtain the measures and the root apex and the most coronal point of the CEJ (for mesial and distal) used as references.

The data obtained in this study can aid in the elaboration of the diagnosis, prognosis and treatment of the periodontal disease, in this area.

The knowledge of the presence as well as the concavities dimensions must be considered at the moment of dental restorations. These concavities can be harmful in the chamber of surgery wounds, provide of membranes in the regenerative procedures as well.

Conclusions

The results, at the methodology employed, based the following conclusions: 1) root length = 13.88±1.47 mm (distal) and 13.76±1.50 mm (mesial), with no statistical difference between them; 2) regarding predominance of concavities in the proximal areas it was noticed that: a) root concavities were present in 100% of the samples and b) there were concavities 2 mm coronally, to JEC and also at JEC; 3) as for width and depth of root concavities of lower central incisors, it was possible to observe: a) they are greater 6 mm apically at JEC and reduced on the coronal and apical thirds at both sides and b) the highest averages in width and depth for distal face were, respectively, 1.825 mm and 0.086 mm, while for mesial face they were, respectively, 2.111 mm and 0.085 mm.

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