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Factors associated with root migration after lower third molar coronectomy - preliminary results

Fatores associados com a migração radicular após coronectomia de terceiros molares inferiores - resultados preliminares

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ABSTRACT

Objective: The aim of this prospective study, with preliminary results, was to evaluate factors related with root migration after lower third molar coronectomy, especially radiographic bone density. **Material and Methods:** Twenty-two patients were submitted to 31 lower third molar coronectomies. Clinical and radiographic evaluation of all patients were performed preoperatively and at 7, 90 and 365 days postoperatively. Sociodemographic, clinical and radiographic data were collected. The root migration was analyzed by the distance from the tooth apex to the mandibular canal, and radiographic bone density above the remaining roots was obtained, both using the software *Image J©*. **Results:** After 1-year follow-up no patients showed paresthesia, symptoms or required reintervention, however all roots showed migration. The mean root migration was 2.66 mm at 90 days, and 3.37 mm at 365 days (p = 0.0007). The rate of migration was higher at the early postoperative period. The simple linear regression test between root migration and radiographic bone density was not significant (R=-0.173 and p=0.453; R=-0.045 and p=0.902; at 90 days and 365 days, respectively) as well as the analysis between root migration and other clinical and radiographic variables. **Conclusion:** It was possible to conclude, based on these preliminary results, that all roots showed migration during the follow-up period. The radiographic bone density increases and, consequently, the root migration rate diminishes within time, however none of the evaluated factors showed significant association with root migration.

KEYWORDS

Bone density; Mandibular nerve; Third molar; Surgery oral.

RESUMO

Objetivo: O objetivo deste estudo prospectivo, com resultados preliminaraes, foi avaliar os fatores relacionados com a migração das raízes após corocetomia de terceiros molares inferiores, especialmente a densidade óssea radiográfica. **Material e Métodos:** Vinte e dois pacientes foram submetidos à 31 coronectomias de terceiros molares inferiores. Avaliação clínica e radiográfica de todos os pacientes foi executada no momento pré-operatório e aos 7, 90 e 365 dias pós-operatórios. Dados sociodemográficos, clínicos and radiográficos foram coletados. A migração das raízes foi analisada pela distância do ápice radicular ao canal mandibular, e a densidade óssea radiográfica foi mensurada acima dos remanescentes radiculares, usando o *software Image J©*. **Resultados:** Após 1 ano de acompanhamento, nenhum paciente apresentou parestesia, sintomatologia ou necessitou reintervenção, porém todas as raízes migraram. A média da migração radicular foi de 2,66mm aos 90 dias e de 3,37mm aos 365 dias (p=0,0007). A taxa de migração foi maior no pós-operatório inicial. O teste de regressão linear simples entre migração das raízes e densidade óssea radiográfica não foi significante (R=-0,173 e p=0,453; R=-0,045 e p=0,902; aos 90 e 365 dias, respectivamanete), assim como a análise entre migration radicular e outras

variáveis clínicas e radiográficas. **Conclusão:** Foi possível concluir, com base nesses resultados prelimiares, que todas as raízes apresetaram migração durante o período de acomapanhamento. A densidade óssea radiográfica aumentou e, consequentemente, a taxa de migration radicular dimininiui com o tempo, porém nenhum dos fatores avaliados mostrou associação significante com a migração das raízes.

PALAVRAS-CHAVE

Densidade óssea; Nervo mandibular; Terceiro molar; Cirurgia bucal.

INTRODUCTION

Coronectomy is an alternative procedure to conventional lower third molar extraction. It is indicated when the dental roots are in close relationship with the inferior alveolar nerve and aims to reduce complications and paresthesia. The technique consists in partial removal of the tooth; the crown is removed, and the residual roots are intentionally left into the alveolar bone [1].

Following coronectomy, clinical and radiographical follow-up is mandatory due to the usual root migration (RM) – from 14% to 81% of cases [1-9], especially in the first six months postoperatively [10]. The migration may lead roots to expose in the oral cavity and need reintervention [11].

RM is more often observed in young female patients, indicating that gender and age may impact the migration rate, which can be explained by a minor bone density of those patients [11-13]. However, there is a lack of studies about the correlation between bone healing after coronectomy and RM. Although RM is reported as a possible outcome after coronectomy, the associated factors are still unknow, especially the role of bone healing above the residual root, represented by the radiographic bone density (RBD). Therefore, the aim was to evaluate the factors associated with RM after lower third molar coronectomy, especially the RBD. The hypothesis assessed was that there would be an inverse relation between RM and RBD, in which the RM would decrease with the increase in bone healing (RBD). This paper presents the preliminary results, after 1-year follow-up.

MATERIALS AND METHODS

Study design and ethical aspects

This prospective study was performed in accordance with the ethical standards postulated in the Helsinki declaration, being approved by the Institutional Review Board of the Federal University of Pelotas Medicine School (protocol n. 909.276). All patients signed an informed consent to participate. STROBE guidelines were used to outline the research.

The sample was selected by an Oral and Maxillofacial Surgeon with 24 years of clinical experience and after clinical and imaging analysis. Inclusion criteria were patients that sought for lower third molar extraction showing radiographic sign of intimate contact between mandibular canal and dental roots, who were invited to participate [13,14]. All patients that agreed with coronectomy procedures and follow-up appointments were included. All included patients had a preoperative panoramic radiograph and Cone Beam Computed Tomography (CBCT).

Exclusion criteria were syndromic patients; use of medications that affect bone metabolism; extremes of age; patients that showed contraindication for surgical procedures; and those in which the root showed mobility during the procedure (conventional extraction was performed in such cases).

Surgical procedure

All procedures were performed by postgraduate students and supervised by an Oral and Maxillofacial Surgeon from the Residency Program in Oral and Maxillofacial Surgery of the Federal University of Pelotas. The applied surgical technique followed the report of Pogrel [4]. All procedures were performed under local anesthesia, followed by incision and mucoperiosteal flap retraction. Osteotomy was performed using #702 bur and tooth sectioning was performed at the cementoenamel junction using #151 Zekrya bur, then crown removal was carefully done using elevators to avoid residual root mobilization. If necessary, wearing of the residual root was done to achieve 3mm under the bone margin.

Then, irrigation and suture were performed. Postoperative medication included Amoxicillin

500 mg orally three times/day or Clindamycin 300 mg orally four times/day; Ibuprofen 600 mg orally three times/day; and Paracetamol 750 mg orally four times/day. Suture removal was done at 7 days postoperatively.

Clinical and radiographic analysis

All patients were evaluated clinically and radiographically at (*T0*) preoperative; (*T1*) 7 days postoperatively; (*T2*) 90 days postoperatively; (*T3*) 365 days postoperatively. The postoperative imaging exams were panoramic radiographs. Tomographs were not performed postoperatively to minimize the patient's exposure to radiation [15].

The preoperative CBCT had been performed in a private Oral Radiology clinic, before the study selection, and was used for: 1) confirming the proximity of the tooth roots with the mandibular canal and the option for the coronectomy technique; 2) helping the surgeon in the surgical procedure. The pre- and postoperative panoramic radiographs were acquired in an X-Mind Tome™ x-ray device (Orion Corporation Soredex, Helsinki, Finland), with exposure factors according to each patient, using the phosphor plates of VistaScan Plus™ digital system (Dürr Dental SE, Bietigheim-Bissingen, Germany). The images were achieved by technicians from the Oral Radiology Service of the Dentistry School where the research was conducted, and the quality of these images was certified by an Oral and Maxillofacial Radiologist.

At *T0*, the following data were collected: gender; age; tooth submitted to coronectomy; third molar relation to oral cavity: intraosseous, submucosal, exposed to oral cavity; Pell and Gregory classification; Winter classification; number and morphology of third molar roots and the distance (mm) between the tooth root apex and the upper cortical bone of the mandibular canal. At *T1*, *T2* and *T3*, clinical exam was performed to observe symptom or need of reintervention. Panoramic radiography was done at *T1* to confirm correct tooth sectioning and absence of enamel. Radiographic evaluation at *T2* and *T3* included: RM - Measurement of the distance between the upper cortical bone of the mandibular canal and the most apical point of the remaining root apex [8]; RBD above the residual root – region where the dental crown was located before surgery.

The RM and RBD were evaluated in an Acer Aspire 3 i5 notebook, 17' LCD screen (Acer Inc., Hsinchu, Taiwan), using the software ImageJ™ 1.52a (National Institutes of Health, USA). One single examiner calibrated by an Oral and Maxillofacial Radiologist, with 20 years of experience, performed the radiographic measures. In the calibration process, after a theoretical explanation, 20 randomly selected radiographs were measured twice, with a 15-day interval between them. The intraexaminer agreement was verified by Intraclass Correlation Coefficient (ICC = 0.97).

The method described by Leung and Cheung [8] was applied to measure RM. According to this method applied in the radiographs, the distance between the most apical point of the tooth root and the upper cortical bone of the mandibular canal was measured, considering the long axis of the roots (Figure 1). The RM was represented by the difference between *T2* or *T3* measurements to the *T0* one. The panoramic radiograph distortion was corrected before these measurements, using the ImageJ™ tool set scale.

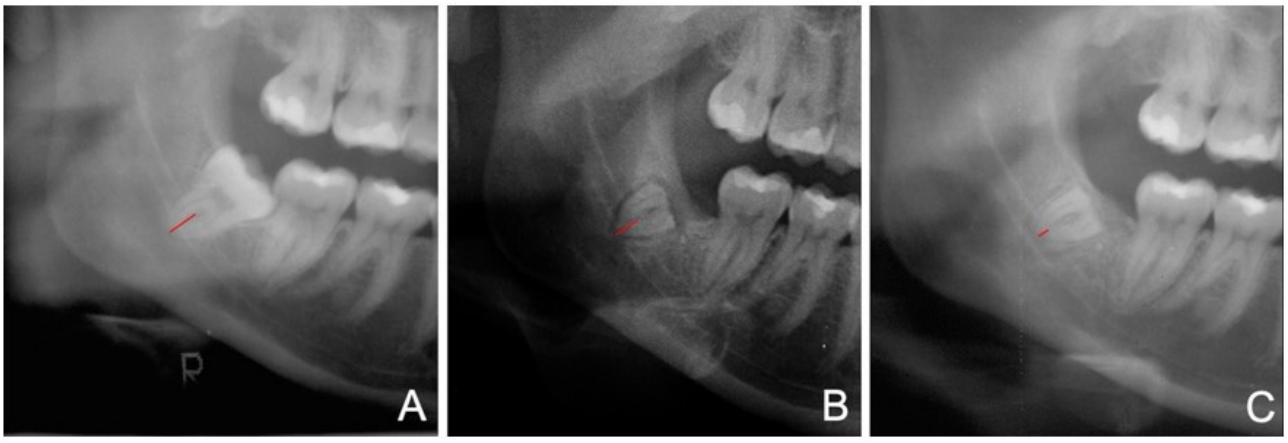

Figure 1 - Panoramic radiographs illustrating the measurements applied for evaluating the RM. A: *T0* (preoperative); B: *T2* (90 days postoperative); C: *T3* (365 days postoperative).

The RBD was obtained from the region where the dental crown was located before coronectomy, using a modification of the method applied by Alissa et al. [16]. An area of 1.5mm^2 made with the ImageJ™ tool square was limited and positioned in the alveolar bone region above the remaining roots. The RBD was measured by the histogram tool, using a grey scale in pixel values – this assessment was performed in triplicate. In order to standardize reference values for panoramic radiographs, the radiographic density of enamel of the distal region of the lower second molar was obtained by the same method (Figure 2).

Statistical analysis

Statistical analysis was performed using IBM SPSS® Statistics 20.0 (Statistical Package for Social Sciences, IBM, USA). A descriptive analysis of the independent variables was done. Shapiro-Wilk test at a significance level of 5% was applied to verify sample normality, which revealed that RM and RBD showed normal distribution ($p > 0.05$). A paired t-test was applied to compare the mean of RM at *T2* and *T3*, and the mean of RDB at *T2* and *T3*. Simple linear regression was applied to correlate RM and RBD at *T2* and *T3*. The mean of RM and the independent variables were analyzed by independent samples t-test or one-way ANOVA, at *T2* and *T3*. All tests were conducted at a significance level of 5%.

RESULTS

To present these preliminary results, after 1-year follow-up, the sample included 22 patients and 31 teeth (coronectomies). Initially, 33 patients and 42 teeth were selected for the procedures; however, 3 teeth/patients were excluded because mobility was observed during the surgical procedure and conventional extraction was made; 8 teeth/patients were excluded due to loss to follow-up.

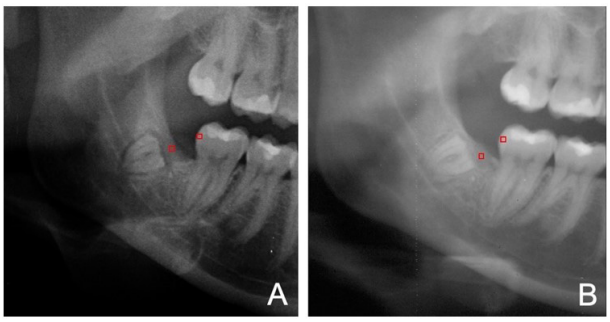

Figure 2 - Panoramic radiographs illustrate the RBD evaluated. The bone density was obtained, in triplicate, in the region above the remaining roots. A: *T2* (90 days postoperatively); B: *T3* (365 days postoperatively). The measurement of enamel density on the distal surface of the second molar was obtained to standardize reference values of density.

Most patients were female (n = 17/77.3%), and the mean age was 27 (±7.81) years, ranging from 19 to 52 years – most of them between 20 to 25 (63.6%). From 31 teeth submitted to coronectomy, 10 were exposed to oral cavity (32.2%), 14 were submucous (45.2%), and 7 were intraosseous (22.6%). Most of them were classified – according to Pell and Gregory - as position II class B (n = 14/45.2%) and position II class A (n = 11/35.5%). According to Winter classification, 15 were mesioangular (48.4%), 9 vertical (29.0%), and 6 horizontal (19.4%). About root characteristics, 21 (67.7%) were multirooted teeth and 10 (32.3%) were single-rooted teeth; moreover, 11 teeth (35.5%) showed fused roots and 10 parallel roots (Table 1).

In the clinical evaluation at *T1*, 20.7% of cases showed pain symptoms and 34.5%

Table 1 - Absolute (n) and relative (%) frequencies of epidemiological, clinical and radiographic characteristics of teeth submitted to coronectomy

Variable	Categories	n	%
3rd molar involved	38	14	45.2
	48	17	54.8
Exposure to oral cavity	Exposed	10	32.2
	Submucous	14	45.2
	Intraosseous	7	22.6
Pell & Gregory classification	I/A	1	3.2
	I/C	1	3.2
	II/A	11	35.5
	II/B	14	45.2
	II/C	2	6.5
	III/A	1	3.2
	III/C	1	3.2
Winter classification	Vertical	9	29.0
	Mesioangular	15	48.4
	Distoangular	1	3.2
	Horizontal	6	19.4
Number of roots	Single-rooted Teeth	10	32.2
	Multirooted Teeth	21	67.7
Root morphology	Fused	11	35.5
	Divergent	6	19.4
	Parallel	10	32.3
	Convergent	4	12.9

presented swelling compatible with the surgical procedure. Only one case showed transitory lingual nerve paresthesia, recovered at 15 days postoperatively. No case of inferior alveolar nerve paresthesia was found. At *T2*, only one patient described a minor discomfort at the surgical site, and other patients were asymptomatic. At *T3*, all patients were asymptomatic, and no exposure of residual roots was observed.

Table 2 shows data and statistical analysis about RM and RBD at *T2* and *T3*. The mean RM was smaller at *T2* (2.71 mm) compared to *T3* (3.51 mm) (p = 0.028); however, the migration rate was higher at *T2* (0.03 mm/day) than at *T3* (0.009 mm/day). RBD also showed statistical difference (p = 0.013) when compared *T2* to *T3*, mean of 116.44 pixels and 92.89 pixels, respectively.

Although the relation between RM and RBD was inversely proportional (Figures 3 and 4) at *T2* (R = -0.173) and *T3* (R = -0.045), there was no significant association between these variables at *T2* (p = 0.453) and *T3* (p = 0.902). The RM means did not show statistical difference according to the other independent variables analyzed (Supplementary Material).

DISCUSSION

The preliminary main findings of this study showed that all roots presented migration after 1-year postoperative follow-up and the mean RM was higher at 1 year compared to 90 days. Also, the RBD increases over time and this result would be explained by the bone healing at post-coronectomy alveolus. However, there was no statistically significant association between RM and RBD, and the other independent variables analyzed also did not show influence over the RM.

RM values were statistically different at *T2* and *T3*. The migration rate was higher at *T2* compared to *T3*. During the first 3 months after coronectomy the mean migration rate was 0.03 mm/day, whereas in the first postoperative year the mean migration rate was 0.009 mm/day. This result corroborates with previous studies [9,17-20], that explain a minor migration rate over time due to

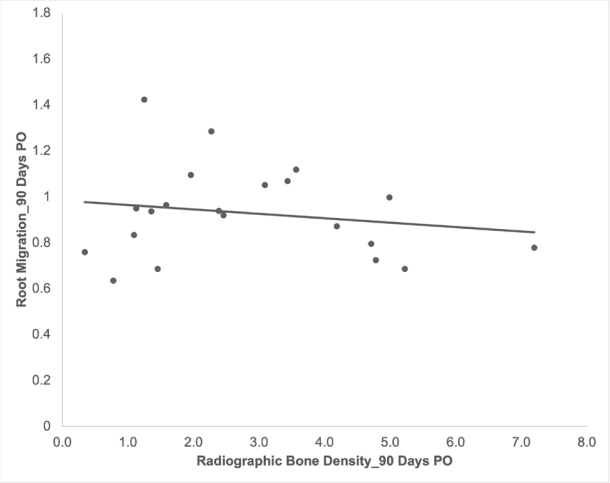

Figure 3 - Relation between root migration (RM) and radiographic bone density (RBD) at 90 days (T2).

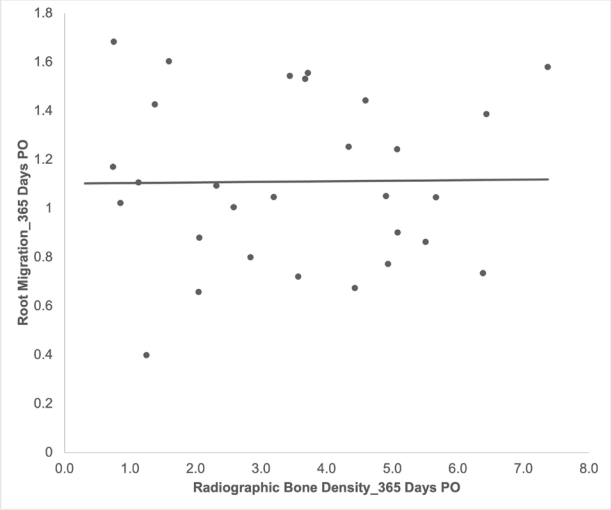

Figure 4 - Relation between residual root migration (RRM) and radiographic bone density (RBD) at 365 days (T3).

Table 2 - Mean, standard deviation (SD), minimum and maximum values of postoperative root migration (RM) and postoperative radiographic bone density (RBD) at T2 and T3

	Mean (SD)	*P* value	Minimum	Maximum
RM (mm)*				
T2	2.71 (±1.77)	0.028	0.34	7.20
T3	3.51 (±2.06)		0.31	7.37
RBD (pixels)*				
T2	92.89 (±20.04)	0.013	63.46	39.84
T3	116.44 (±34.70)		142.28	168.33

*Variable with statistically significant difference by paired t-test.

bone healing and increase of bone density, which lead to obstacles to RM.

Regarding RBD there was statistical difference at *T2* and *T3*. This finding demonstrates bone healing after coronectomy and the increase of bone density over time. Comparison between RBD and RM showed an inverse relation, therefore as bone density increases RM tends to decrease. Consequently, the hypothesis assessed in this study was confirmed. However, the linear regression test, which evaluated the statistical relation between these variables, was not significant. To the best of our knowledge, there is no report in the literature about the relationship between RM and RBD, precluding the comparison with other studies. Thus, future studies may confirm this inverse relation as well as the lack of association between these measures.

According to Monaco et al. [20] and Patel et al. [21], isolated migration is not an absolute indication to residual root removal after coronectomy. Reintervention is recommended when root migrate up to oral exposure [4,17,21]. In fact, in a systematic review performed by Barcellos et al. [11], the authors verified that reintervention is rarely necessary, only 5.1% of cases had residual root removal, and the indications were oral exposure of the residual root or clinical symptoms. Moreover, Leung and Cheung [22] reported that, when oral exposure of residual root occurs and it is removed, no case showed IAN paresthesia and the main purpose of coronectomy was achieved. In this study with preliminary results, after 1-year follow-up, none of the cases showed oral exposure or clinical symptoms, therefore reintervention was not performed. However, it is believed that a longer follow-up is recommended because there are reports of late oral exposure of the residual root, even 10 years after coronectomy [6,18].

About RM rate, some authors report age as a factor that influence its speed [9,11,13,18,19,23,24]. With these preliminary results, no statistical difference was observed comparing age and RM rate. This may have occurred because the majority of patients were at the same age group – 63.6% at 20 to 25 years.

This preliminary study also did not show influence of gender on RM. The main explanation for this is the homogenous sample, in which 77.3% of patients were women. The literature is not clear about the relation between gender and RM; some studies indicate that women have higher RM compared to men [13,20,23,25] whereas others [17,18] have not established this relation.

About the characteristics of dental roots, Goto et al. [25] reported that the number and morphology may influence RM rate, with higher tendency to migration in convergent roots and single-rooted teeth. With these preliminary results there were no differences regarding root number and morphology, as well as tooth angulation and degree of impact to RM. These findings are similar to Leung and Cheung [17].

One limitation of this study was the application of panoramic radiographs to measure RM. Panoramic radiography is a bidimensional exam and migration may occur in all directions. The gold standard for tridimensional evaluation in dentistry is the CBCT exam [26]. However, CBCT was not superior to panoramic radiography in avoiding damage to the IAN [27] and according to radiation protection principles, CBCT are not elected as standard exam for postoperative evaluations, especially when these analyses are repeated over time, since it has higher cost and radiation exposure [15]. Therefore, although CBCT allows tridimensional analysis, it is suggested that future studies applied similar methodology using panoramic exams. Another point is the sample size. This is an ongoing study, and the small number of subjects is a limitation at this moment. However, this sample can point to further studies regarding the evaluation of RBD after coronectomy and its relation to RM, an area in which the studies are still incipient.

The possible externalization of roots in the oral cavity due to migration, and the consequent need for surgical reintervention, are one of the main causes for the lack of confidence by professionals when choosing the coronectomy technique. Thus, this study is clinically relevant for revealing that the rate of RM decreases in the longer postoperative follow-up periods and with the bone healing process, suggesting that the externalization of roots may not occur. Therefore, a greater number of professionals could start performing coronectomies when lower third molar roots close to the mandibular canal need to be extracted.

CONCLUSION

Preliminarily, it was possible to conclude that RM after coronectomy occurred in all evaluated cases, with higher migration rate at 90 days postoperatively compared to 1 year. The RBD increases and the RM rate decreases over time. There was no case of paresthesia or residual root exposure, which reinforces that coronectomy is a safe and efficient technique to prevent IAN impairment when the dental roots are in close relationship with the mandibular canal.

Author Contributions

Karoline Von Ahn Pinto (DDS) - Responsible for the follow-up, data collection and was write the article. Bibiana Dalsasso Velasques (MSC) - Surgeon who performed the coronectomies, follow-up and was writing the article.Lucas Borin Moura (PhD) - Surgeon who performed the coronectomies and co-advisor. Melissa Feres Damian (PhD) - Radiologist, responsible for radiographic and statistical analysis, co-advisor. Cristina Braga Xavier (PhD) - Supervisor of research and Senior Surgeon.

Conflict of Interest

No conflicts of interest declared concerning the publication of this article.

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Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of: Federal University of Pelotas Medicine School. The approval code for this study is: Protocol n. 909.276.

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