

---

**EXPERIMENTAL & CLINICAL CARDIOLOGY**

---

Volume 20, Issue 8, 2014

Title: "Changes in Heart Period During Endodontic Treatment"

Authors: Milana Santana, Ana Cecilia Amorim De Souza, Elizangela Vilar De Assis, Luiz Carlos De Abreu and Vitor Engracia Valenti

How to reference: Changes in Heart Period During Endodontic Treatment/Milana Santana, Ana Cecilia Amorim De Souza, Elizangela Vilar De Assis, Luiz Carlos De Abreu and Vitor Engracia Valenti/Exp Clin Cardiol Vol 20 Issue8 pages 3389-3398 / 2014

Experimental & Clinical Cardiology

# Changes in heart period during endodontic treatment

*Original Article*

Milana Drumond Ramos Santana\*<sup>1</sup>, Ana Cecília Amorim de Souza<sup>1</sup>, Elisangela Vilar de Assis<sup>1</sup>, Luiz Carlos de Abreu<sup>1</sup>, Vitor Engrácia Valenti<sup>1,2</sup>

<sup>1</sup>Laboratório de Escrita Científica, Faculdade de Medicina do ABC, Santo André, SP, Brasil.

<sup>2</sup>Departamento de Fonoaudiologia, Faculdade de Filosofia e Ciências, UNESP, Marília, SP, Brasil.

**Abstract**

**Background:** Tooth extraction was demonstrated to increase sympathetic modulation of the heart, however, it is not understood the effects of endodontic treatment on cardiac autonomic regulation. We evaluated heart rate variability (HRV) during endodontic treatment. **Method:** 50 male and female patients aged between 18 and 40 years old and diagnosed with irreversible pulpitis or pulp necrosis of the lower molars with indication of gender endodontic treatment were analyzed. HRV was analyzed in the time (SDNN, RMSSD, pNN50) and frequency (LF, HF and LF/HF ratio) domains recorded in the first session of root canal treatment. The indices were analyzed in the following periods: T1) ten minutes before the endodontic treatment, T2) ten minutes after the administration of anesthesia before endodontic treatment, T3) during the entire period of endodontic treatment and T4) thirty minutes after the end of the endodontic treatment. **Results:** The SDNN, RMSSD and pNN50 indices increased at T2 compared to T1, the pNN50 and RMSSD indices increased at T3 and T4 compared to T2. The LF in normalized units increased at T4 compared to T2 and in absolute units it was increased at T4 compared to T1. The HF in normalized units was reduced at T4 compared to T2 and in absolute units was reduced at T1, T3 and T4 compared to T2. The LF/HF ratio was higher at T4 compared to T2. **Conclusion:** The global modulation of heart increases after local anesthesia and vagal tone reduce during surgery procedures and after the surgical procedures.

**Keywords:** Dental caries; Autonomic nervous system; Cardiovascular physiology.

**1. Introduction**

Endodontics is defined as the field of dentistry with respect to morphology, physiology and pathology of human dental pulp and periapical tissues. The endodontic treatment consists in maneuver of various techniques in order to restore the normal dental tissues [1].

Endodontic treatment involves several stages, ranging from anesthesia to obturation of the root canal system that is performed by technical operative steps that may undergo various types of failures and complications in clinical evolution [2]. According to Ferraz et al. [3], endodontic treatment promotes psychosomatic changes capable of initiating hypertensive crises that may compromise the function of vital organs and cause accidents of unexpected

proportions. It is triggered a series of phenomena in the body that determine the elevation of blood pressure and heart rate.

A well recognized method that analysis the cardiovascular system is heart rate variability (HRV) [4]. The power spectral analysis of RR variability has been widely used to assess cardiac autonomic modulation [5]. The analysis can also be performed using linear methods in the time domain [6]. The time domain indices include the standard deviation of all normal RR cycles during registration (SDNN), root-mean square of differences between adjacent normal RR intervals in a time interval (RMSSD) and percentage of variation greater than 50 milliseconds between successive normal cycles (pNN50). The frequency domain is based on spectral analysis and considers different frequency responses observed in the electrocardiographic signal. It usually encloses two distinct frequency bands called high (HF) and low (LF) frequency. The high frequency values ranges from 0.15 to 0.40 Hz and corresponds to the respiratory modulation, it is an indicator of the performance of the vagus nerve on the heart. The low frequency values ranges between 0.04 and 0.15 Hz and is modulated by both the sympathetic and the parasympathetic nervous system. Because the autonomous system operates both at low and at high frequency, the relationship between them (LF/HF) can be considered a measure of sympathovagal balance, and it reflects the absolute and relative interactions between the sympathetic and parasympathetic components of the autonomic nervous system on the heart [4].

Although a previous study showed that tooth extraction activated the sympathetic nervous system [7], it is not known yet if caries removal and access to the pulp chamber induce changes in the cardiac autonomic regulation. In addition, the knowledge of physiological responses involved in endodontic treatment is important for providing a better treatment plan for the patient, and greater security to the endodontist. Therefore, we aimed to evaluate cardiac autonomic regulation during endodontic treatment.

**2. Method****Study Population**

We analyzed a total of 50 subjects indicating endodontic treatment, from both genders aged between 18 and 40 years old. All volunteers were informed about the procedures and objectives of the

study and, after agreeing, have signed a term of informed consent. All study procedures were approved by the Ethics Committee in Research of the Faculty of Sciences of the Faculdade Leão Sampaio (Protocol No. 193.889) and followed the resolution 196/96 National Health 10/10/1996.

#### **No inclusion criteria**

We did not include subjects under the following conditions: body mass index (BMI) >35 kg/m<sup>2</sup>; systolic blood pressure (SBP)>140 mmHg or diastolic blood pressure (DBP) >90 mmHg (at rest); cardiac arrhythmias (atrial flutter or fibrillation, multiple ventricular or atrial ectopy, second or third degree atrioventricular block), smoking, left ventricular dysfunction, neurological or respiratory disorders and serious postural deviation in the chest such as severe scoliosis, kyphosis or hyperlordosis that could influence the respiratory pattern.

#### **Initial Evaluation**

Before the experimental procedure, volunteers were identified by collecting the following information: age, gender, weight, height and body mass index (BMI). Weight was determined by using a digital scale (W 200/5, Welmy, Brazil) with a precision of 0.1kg. Height was determined by using a stadiometer (ES 2020, Sanny, Brazil) with a precision of 0.1 cm and 2.20 m of extension. Body mass index (BMI) was calculated using the following formula: weight / height<sup>2</sup>, weight in kilograms and height in meters.

#### **HRV analysis**

The R-R intervals recorded by the portable HR monitor (with a sampling rate of 1000 Hz) were uploaded to the Polar Precision Performance program (v. 3.0, Polar Electro, Finland). The software enabled the visualization of HR and the extraction of a cardiac period (R-R interval) file in downloadable ".txt" format. Following digital filtering complemented with manual filtering for the elimination of premature ectopic beats and artifacts, at least 256 R-R intervals were used for the data analysis. Only series with more than 95% sinus rhythm was included in the study. HRV was analyzed at four moments the first session of endodontic treatment: 1) ten minutes before the endodontic treatment, 2) ten minutes after the administration of anesthesia before endodontic treatment, 3) during the entire period of endodontic treatment and 4) thirty minutes after the end of the endodontic treatment. We evaluated the linear indices of HRV. For calculation of the indices we used the HRV Analysis software (Kubios HRV v.1.1 for Windows, Biomedical Signal Analysis Group,

Department of Applied Physics, University of Kuopio, Finland) [8].

To analyze HRV in the frequency domain, the low frequency (LF =0.04 to 0.15 Hz) and high frequency (HF = 0.15 to 0.40 Hz) spectral components were used in normalized units (nu), which represents a value relative to each spectral component in relation to the total power minus the very low frequency (VLF) components, and the ratio between these components (LF/HF). The spectral analysis was calculated using the Fast Fourier Transform algorithm.

The analysis in the time domain was performed by means of SDNN (standard deviation of normal-to-normal R-R intervals), the percentage of adjacent RR intervals with a difference of duration greater than 50ms (pNN50) and RMSSD (root-mean square of differences between adjacent normal RR intervals in a time interval) [4].

#### **Endodontic treatment procedures**

The endodontic treatment was performed by a only therapist in two sessions and followed all the steps of endodontic treatment. Firstly, anesthesia was administrated in the inferior alveolar nerve (Lidocaine 2% - SS White ®), we performed caries removal and access to the pulp chamber (diamond burs spherical No. 1012, 1014 and 1015 - KG Sorensen ®) compatible with the size of the pulp chamber, mounted on high-rotation turbine, air-cooled water and Endo Z drill (Les Fils d'August Mailefer SA ®). It was performed isolation of the operative field with rubber dam, chemo-mechanical preparation of root canals (hand files Flexofile Dentsply ® and hiploclorito sodium 2.5%); channel drying (paper cones Dentsply ®), intacanal medication (callen SSWhite ®); and placement of cotton ball in entrance of the temporary sealing canal (IRM ®).

#### **Protocol**

Data collection was carried out in the same sound-proof room for all volunteers with the temperature between 21°C and 25°C and relative humidity between 50 and 60% and volunteers were instructed not to drink alcohol and caffeine for 24 hours before evaluation. Data were collected on an individual basis, between 8 and 12 AM to standardize the protocol. All procedures necessary for the data collection were explained on an individual basis and the subjects were instructed to remain at rest and avoid talking during the collection.

After the initial evaluation the heart monitor belt was then placed over the thorax, aligned with the distal third of the sternum and the Polar RS800CX

heart rate receiver (Polar Electro, Finland) was placed on the wrist.

### Statistical Analysis

Standard statistical methods were used to calculate the means and standard deviations. The normal Gaussian distribution of the data was verified by the Shapiro-Wilk goodness-of-fit test ( $z$  value of  $>1.0$ ). For parametric distributions we applied ANOVA for repeated measures test followed by the Bonferroni posttest. For non-parametric distributions we used Friedman test followed by the Dunns posttest. We compared the HRV indices between the four moments: 1) ten minutes before the endodontic treatment, 2) ten minutes after the administration of anesthesia, 3) during the entire period of endodontic treatment and 4) thirty minutes after the end of the endodontic treatment. Differences were considered significant when the probability of a Type I error was less than 5% ( $p < 0.05$ ). We used the Software GraphPadStatMate version 2.00 for Windows, GraphPad Software, San Diego California USA.

### 3. Results

We observed no difference between before and after the procedures for systolic blood pressure ( $p=0.9584$ ) and diastolic blood pressure ( $p=0.8984$ ). We present in Table 1 values regarding baseline diastolic (DAP) and systolic arterial pressure (SAP), heart rate (HR), mean RR interval, weight, height and body mass index (BMI) of the volunteers.

In relation to the time domain indices, it was observed that there was an increase of SDNN at T2 compared to T1. The pNN50 index increased at T2 compared to T1 and was higher at T3 and T4 compared to T2. Regarding the RMSSD index, it increased at T2 compared to T1 and increased at T3 and T4 compared to T2 (Table 2).

In Table 3 we note the changes of the HRV time domain indices. The LF in normalized units increased at T4 compared to T2 while the same index in absolute units ( $ms^2$ ) was increased at T4 compared to T1. The HF in normalized units was reduced at T4 compared to T2 and the HF in absolute units ( $ms^2$ ) was reduced at T1, T3 and T4 compared to T2. The LF/HF ratio was higher at T4 compared to T2.

Figure 1 shows an example of the visual evaluation of the power spectrum density analysis observed in one subject before the endodontic treatment (Figure 1A), after the administration of local anesthesia (Figure 1B), during the entire period of endodontic treatment (Figure 1C) and after the end of the endodontic treatment (Figure 1D). It is observed

that the HF band is increased after the administration of anesthesia before endodontic treatment.

### 4. Discussion

Our study aimed to investigate the autonomic modulation of the heart during the first session of the endodontic treatment of inferior molars, in which anesthesia, coronary access, isolation of the operative field, exploration and instrumentation of the root canals were performed and finally it was made intraradical medication and temporary sealing. All steps were performed by a single operator. According to our results, it was found that after application of local anesthesia is HRV increased, featured by increased parasympathetic modulation of the heart, that recovered to the initial values during and after endodontic treatment and increased sympathetic tone on the heart after the endodontic treatment.

Based on our data, the SDNN index was increased during local anesthesia period with no endodontic intervention compared to before local anesthesia administration. The SDNN corresponds to global variability of heart rate [9]. This index was observed to be reduced in patients with chronic obstructive pulmonary disease [10], with stable angina [11] and during exercise [12], indicating decreased HRV during those conditions. Local anesthesia decreases phases of myocardial depolarization and reduce the myocardial electrical excitability, conduction velocity and force of contraction [13]. A previous study used axillary approach for brachial plexus block in order to investigate changes in cardiac autonomic regulation through HRV analysis in patients under local anesthesia [14]. The authors also observed increased HRV induced by the mentioned procedure. In this sense, we suggest that local anesthesia in the inferior alveolar nerve acutely increases HRV.

We also reported increased levels of pNN50 and RMSSD during local anesthesia procedure with no surgical intervention compared to control (before surgery). During endodontic treatment the time domain cited above indices recovered to basal levels. The RMSSD and pNN50 time domain indices of HRV represents vagal tone on the heart [4]. Parasympathetic regulation of the heart was also increased in patients during local anesthesia in the brachial plexus [14, 15]. Our results corroborate the research [16], in which it was assessed changes in blood pressure, pulse and HRV during dental surgery. The authors observed that the LF/ HF index reduced during local anesthesia with no surgical intervention.

Decrease in the of LF/HF ratio was also reported by Miura et al. [5] evaluated the changes in cardiac autonomic regulation during dental surgery in hypertensive patients. However, the authors observed that LF/HF did not change during tooth extraction in normotensive patients. In contrast, the HF content was significantly decreased in normotensive patients over a local anesthetic and recovery period. The authors concluded that the suppression of the cardiac sympathetic regulation during dental surgery may attenuate the response in patients with hypertension. Supporting their findings, we also found no change in HRV during the endodontic procedures compared to control condition (before all procedures).

Parallel to our findings, there was increase in the HF component of the spectral analysis, indicating an increase of vagal control for dexmedetomidine anesthetics and propofol [17], but also decreased LF/HF ratio after general anesthesia [18]. Indeed, the spectral analysis of HRV can provide important information regarding the influence of general and local anesthesia on the cardiovascular neural control and depth of the anesthetic procedures [17,18]. HRV has been shown to be a useful parameter for detecting even small cardiovascular changes than other non-invasive tools for patients who are submitted to endodontic procedures.

According to our results, there was no difference in systolic blood pressure and diastolic blood pressure in the four study periods, i.e. early in the dental surgery, immediately after anesthesia during dental extraction and five minutes after tooth extraction. On the other hand, heart rate values were significantly different in three of the four periods and HRV indices were significantly different in all four test periods. However, in another study [19] it was noted that local anesthesia containing epinephrine decreased systolic blood pressure in hypertensive patients and arteial diastolic pressure in normotensive and hypertensive subjects. Conversely, a previous investigation found increase in plasma epinephrine levels during local anesthesia with Lidocaine 2% that was reduced during dental surgical procedures accompanied by increase in systolic blood pressure during surgery [7].

Before conducting this study, we surmised that the LF/HF ratio, which corresponds to the sympathetic modulation of the heart, would be increased during endodontic surgical procedures due to psychological stress, epinephrine contained in the local anesthetic and/or painful stimuli. However, in our investigation it was not significantly higher than the period before surgery, but was significantly higher

than during local anesthesia. Similar to our study, it was reported reduced sympathetic modulation of the heart through decreased LF/HF ratio during a mixture of lignocaine and bupivacaine. Moreover, another study from the same group performed empirical mode decomposition analysis of RR intervals in patients under local anesthesia (brachial plexus block with Bupivacaine and Lignocaine) and observed reduced sympathetic modulation of the heart within an hour of the application of the anesthesia [15]. However, the anesthetic procedures were different from our protocol, the authors [14] used a combination of 30 ml Lignocaine and 29 ml of 0.5% Bupivacaine in the brachial plexus while we used Lidocaine 2% for anesthesia of the mandibular molars with epinephrine 1:80,000, with one standardized cartridge (1.8 ml) for pterigomandibular technique of regional anesthesia with blockade of the lower alveolar nerve and lingual nerve and one cartridge (1.8 mL) for infiltration anesthesia.

Anxiety and fear during endodontic treatment were elated by a large number of patients during our study. These feelings may induce significant autonomic changes, determining physiological changes linked to the activity of the sympathetic nervous system, expressed as pallor, sweating palms, tremors, difficulty communicating and tachycardia [20]. It is possible that the anesthetic increased HRV by attenuating the effects of anxiety on cardiac autonomic regulation.

There are some physiological mechanisms based on the centrl nervous system that may explain the changes in cardiac autonomic regulation reported in our study during local anesthesia in the inferior alveolar nerve. The inferior alveolar nerve, also known as inferior dental nerve, is a branch of the mandibular nerve, which is the third branch of the trigeminal nerve [21]. In this context, the trigeminal depressor response is explained as reductions of arterial blood pressure and heart rate induced by electrical stimulation of the branches of the trigeminal nerve [22]. It was previously hypothesized in rats that the trigeminally induced cardiovascular reflex is mediated initially in the trigeminal nucleus caudalis [23]. Furthermore, the trigeminal motor nucleus was reported to make connections with neurons in the brainstem [24] that are related to cardiovascular and respiratory reflex in animals that surround the fourth cerebral ventricle [25, 26].

## 5. Conclusion

During endodontic treatment global modulation of heart rate increases immediately after local anesthesia and the parasympathetic components of the cardiac modulation reduce during surgery procedures and after the surgical procedures.

## 6. Acknowledgements

This study received financial support from Faculdade de Medicina do ABC.

## 7. References

1. Sen BH, Piskin B, Baran N: The effect of tubular penetration of root canal sealers on dye microleakage. *International endodontic journal* 1996, 29:23-28.
2. Duarte MA, Ordinola-Zapata R, Bernardes RA, Bramante CM, Bernardineli N, Garcia RB, et al: Influence of calcium hydroxide association on the physical properties of AH Plus. *Journal of endodontics* 2010, 36:1048-1051.
3. Ferraz EG, Carvalho CM, Jesuino AA, Provedel L, Sarmiento VA: Evaluation of arterial pressure variation during the dental surgical procedure. *Rev Odontol UNESP* 2007, 36:223-229.
4. Vanderlei LC, Pastre CM, Hoshi RA, Carvalho TD, Godoy MF: Basic notions of heart rate variability and its clinical applicability. *Rev. Bras. Cir. Cardiovasc* 2009, 24:205-217.
5. Miura K, Matsumura K, Nakamura Y, Kurokawa H, Kajiyama M, Takata Y: Suppression of cardiac sympathetic nervous system during dental surgery in hypertensive patients. *Hypertens Res* 2000, 23:207-212.
6. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology: Heart rate variability: standards of measurement, physiological interpretation and clinical use. *Circulation* 1996, 93:1043-1065.
7. Nakamura Y, Matsumura K, Miura K, Kurokawa H, Abe I: Cardiovascular and sympathetic responses to dental surgery with LA. *Hypertens Res*. 2001, 24:209-214.
8. Moreno IL, Pastre CM, Ferreira C, de Abreu LC, Valenti VE, Vanderlei LC: Effects of an isotonic beverage on autonomic regulation during and after exercise. *J IntSoc Sports Nutr* 2013, 10:2.
9. Abreu LC: Heart rate variability as a functional marker of development. *J Hum Growth Dev* 2012, 22:279-281.
10. Carvalho TD, Pastre CM, de Godoy MF, Ferreira C, Pitta FO, de Abreu LC, Ramos EM, Valenti VE, Vanderlei LC: Fractal correlation property of heart rate variability in chronic obstructive pulmonary disease. *Int J Chron Obstruct Pulmon Dis*. 2011, 6:23-28.
11. Pivatelli FC, Dos Santos MA, Fernandes GB, Gatti M, de Abreu LC, Valenti VE, Vanderlei LC, Ferreira C, Adami F, de Carvalho TD, Monteiro CB, de Godoy MF: Sensitivity, specificity and predictive values of linear and nonlinear indices of heart rate variability in stable angina patients. *Int Arch Med*. 2012, 5:31.
12. Raimundo RD, de Abreu LC, Adami F, Vanderlei FM, de Carvalho TD, Moreno IL, Pereira VX, Valenti VE, Sato MA: Heart rate variability in stroke patients submitted to an acute bout of aerobic exercise. *Transl Stroke Res*. 2013, 4:488-499.
13. Sugi K: Pharmacological restoration and maintenance of sinus rhythm by antiarrhythmic agents. *J cardiol* 1999, 33:59-64.
14. Shafqat K, Pal SK, Kumari S, Kyriacou PA: Changes in Heart Rate Variability in patients under local anesthesia. *Conf Proc IEEE Eng Med Biol Soc*. 2007, 2007:299-302.
15. Shafqat K, Pal SK, Kumari S, Kyriacou PA: Empirical mode decomposition analysis of HRV data from patients undergoing local anaesthesia (brachial plexus block). *Physiol Meas*. 2011, 32:483-497.
16. Matsumura K, Miura K, Takata Y, Kurokawa H, Kajiyama M, Abe I, et al: Changes in blood pressure and heart rate variability during dental surgery. *Am J Hypertens* 1998, 11:1376-1380.
17. Tarvainen MP, Georgiadis S, Laitio T, Lipponen JA, Karjalainen PA, Kaskinoro K, Scheinin H: Heart rate variability dynamics during low-dose propofol and dexmedetomidine anesthesia. *Ann Biomed Eng*. 2012, 40:1802-1813.
18. Wang Y, Li C. [Continuous wavelet analysis of heart rate variability during

- general anesthesia]. *Sheng Wu Yi Xue Gong Cheng Xue Za Zhi*. 2012, 29:359-364.
19. Chaudhry S, Iqbal HA, Izhar F, Mirza KM, Khan NF, Yasmeen R, Khan AA: Effect on blood pressure and pulse rate after administration of an epinephrine containing dental local anaesthetic in hypertensive patients. *J Pak Med Assoc*. 2011,61:1088-1091.
  20. Alvares GA, Quintana DS, Kemp AH, Van Zwieten A, Balleine BW, Hickie IB, Guastella AJ: Reduced heart rate variability in social anxiety disorder: associations with gender and symptom severity. *PLoS One*. 2013, 8:e70468.
  21. Joo W, Yoshioka F, Funaki T, Mizokami K, Rhoton AL J: Microsurgical anatomy of the trigeminal nerve. *Clin Anat*. 2014, 27:61-88.
  22. Kumada M, Dampney RA, Whitnall MH, et al: Hemodynamic similarities between the trigeminal and aortic vasodepressor responses. *Am J Physiol*. 1978, 1:H67-H73.
  23. de Sousa Buck H, Caous CA, Lindsey CJ: Projections of the paratrigeminal nucleus to the ambiguous, rostroventrolateral and lateral reticular nuclei, and the solitary tract. *Auton Neurosci*. 2001, 87:187-200.
  24. Oka A, Yamamoto M, Takeda R, Ohara H, Sato F, Akhter F, Haque T, Kato T, Sessle BJ, Takada K, Yoshida A: Jaw-opening and -closing premotoneurons in the nucleus of the solitary tract making contacts with laryngeal and pharyngeal afferent terminals in rats. *Brain Res*. 2013, 2:48-63.
  25. Valenti VE, Abreu LC, Sato MA, Ferreira C: ATZ (3-amino-1,2,4-triazole) injected into the fourth cerebral ventricle influences the Bezold-Jarisch reflex in conscious rats. *Clinics* 2010, 65:1339-1343.
  26. Valenti VE, de Abreu LC, Fonseca FL, Adami F, Sato MA, Vanderlei LC, Ferreira LL, Rodrigues LM, Ferreira C: Effects of the administration of a catalase inhibitor into the fourth cerebral ventricle on cardiovascular responses in spontaneously hypertensive rats exposed to sidestream cigarette smoke. *Clinics* 2013, 68:851-857.

**Table 1.** Baseline diastolic (DAP) and systolic arterial pressure (SAP), heart rate (HR), mean RR interval, weight, height and body mass index (BMI) of the volunteers. Mean±standard-deviation.m: meters; ms: millisecond; kg: kilograms; bpm: beats per minute; mmHg: millimeters of mercury.

Variable	Value
Age (years)	26.6±5.93
Height (m)	1.63±0.084
Weight (kg)	63.97±12.95
BMI (kg/m <sup>2</sup> )	23.86± 3.92
HR (bpm)	76.95±14.39
Mean RR (ms)	807.08±137.32
SAP (mmHg)	122.53±14.03
DAP (mmHg)	83.37± 11.65

**Table 2.** Mean and standard deviation for time-domain indices between T1, T2, T3 and T4. SDNN - standard deviation of normal-to-normal R-R intervals; pNN50 - the percentage of adjacent RR intervals with a difference of duration greater than 50ms; RMSSD - root-mean square of differences between adjacent normal RR intervals in a time interval.ms – millisecond.\*p<0.05: vs.T2.

Index	T1	T2	T3	T4	p value
SDNN (ms)	49.88±13.22*	59.42± 19.73	58.65±15.50	59.49±29.05	0.0201
pNN50	19.12±15.69*	33.11±20.52	23.59±17.25*	22.97±17.45*	<0.0001
RMSSD (ms)	39.24±19.35*	54.09± 24.05	43.37±19.23*	46.68± 40.27*	<0.0001

**Table 3.** Mean and standard deviation for time-domain indices between T1, T2, T3 and T4. LF - low frequency; HF - high frequency; LF/HF - low frequency/high frequency ration; ms - milliseconds; nu - normalized units.\*p<0.05 vs.T1; \*\*p<0.05: vs. T2.

Index	T1	T2	T3	T4	p value
LF (nu)	52.44±19.19	41.36± 20.22	52.61±16.84	58.78±17.36**	0.0004
LF (ms <sup>2</sup> )	584.87±326.49	787.4±687.24	643.43±338.84	911.04± 631.74*	0.0007
HF (nu)	47.39±19.16	58.43±20.16	47.17±16.87	40.48±16.79**	0.0004
HF (ms <sup>2</sup> )	621.85±465.52**	1060.88±835.88	713.17±588.24**	675.19±537.01**	0.0004
LF/HF	1.57±1.44	1.18±1.0	1.41±1.04	2.0±1.61**	0.0026

FIGURE LEGENDS

**Figure 1.** Visual evaluation of the power spectrum density analysis observed in one subject before the endodontic treatment (A), after the administration of local anesthesia (B), during the entire period of endodontic treatment (C) and after the end of the endodontic treatment (D).

