

Orthodontic Patients Posterior Teeth Periodontium Hemodynamics Upon Applying Niti Wires of Different Cross-Sections

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Abstract

The research included 37 orthodontic patients from 18 to 30 years old with narrow upper arch using fixed appliances. Periodontium hemodynamics was studied with focusing reperiodontography method and two-electrode tetrapolar technique. After the impressions were taken, the perforations were made from the vestibular and oral surfaces at the electrodes location sites to limit the RPG registration zone to the interdental space.

Upper premolars and molars periodontium was studied before and after the braces fixation and applying NiTi wire 12, then, after changing for 14, 16, 0.16 x 0.22 and 0.17 x 0.25. After 30 days of every wire change the measurement was repeated. A rheography index (RI) was increased which is an indicator of periodontium blood filling intensity. The initial vascular tone (VT) increased by 70.6% and depends on the physiological state of the periodontium vessel walls.

The reperiodontography changes observed during orthodontic treatment upon different wires application supports the notion that the local response is the physiology functioning law.

Keywords: Periodontium Hemodynamic; Focusing Reperiodontography Method; Orthodontic Treatment; Rheography Index

Introduction

Reperiodontography is based on the graphic registration of the periodontium resistance changes upon applying electricity; the vessel walls state is analyzed [1]. Normally, reperiodontogram is characterized by fast increase, sharp peak and well-defined incisures [2]. An average peripheral resistance index is 74.7%, elasticity index - 94.4%. Maxilla is mainly characterized by hypotonia, mandibula - by hypertonia.

This method is widely used in dentistry: on a tooth level - reodontography, on a TMJ level - rearthrography, on a periodontium level - reoperiodontography. The following elements are shown on a rheogram: ascending part - anacrotic limb, peak, descending part, decaying limp, incisure and dicrotic zone [3-8].

Microcirculation and microhemodynamics analysis allows detecting tissue malfunctioning on an early stage with the help of reoperiodontography, periostometry, capillaroscopy, ultrasonic dopplerography, laser Doppler flowmetry, etc [9-11]. Periodontium microcirculatory vessels compression and further possible tissue changes during orthodontic treatment depend on the individual responsiveness, periodontium state and on the kind and duration of the orthodontic forces applied [12-14].

Information on periodontium microhemodynamics opens new possibilities in orthodontics as one of its purposes is periodontium disease prevention [10,15,16]. Microcirculation study in the maxillary lateral teeth indicates blood flow reaction to the forces applied and allows correcting them to avoid unwanted consequences while maintaining the treatment effect and making it physiological and safe.

There is little information on the evaluation of maxillary lateral teeth periodontium reaction to the orthodontic forces with the help of focusing reoperiodontography in the professional literature. There is no data on the lateral teeth periodontium reaction upon changing the wires of different cross-section [17-19].

Objectives of the Study

Evaluate periodontium reaction to the orthodontic forces applied in the maxillary lateral segments with the help of focusing reoperiodontography

Materials and Methods

The research included 37 orthodontic patients of the Orthodontic Department, MFP and Dentistry MSMSU Clinical Centre, aged 18 to 30 with narrow upper arch using fixed appliances. Periodontium hemodynamics was studied with focusing reoperiodontography method and two-electrode tetrapolar technique. At first, the impressions were taken, then perforations were made from the vestibular and oral surfaces at the electrodes location sites; this limited the RPG registration zone to the interdental space which detects periodontium intraosseous blood vessels state based on the rheogram figures.

Upper premolars and molars periodontium was studied before and after the braces fixation and applying NiTi wire 12, then, after changing it for 14, 16, 0.16 x 0.22 and 0.17 x 0.25. After 30 days of every wire change the measurement was repeated to identify the orthodontic patients periodontium reaction during the standard treatment plan for malocclusion cases with the wire sequences.

This parameter was studied with the help of computer tomography data visualization program i-CAT Vision on the cross-section x-ray image 3 - 4 mm from the alveolar edge at the centre of the root (crown) level (Figure 1).

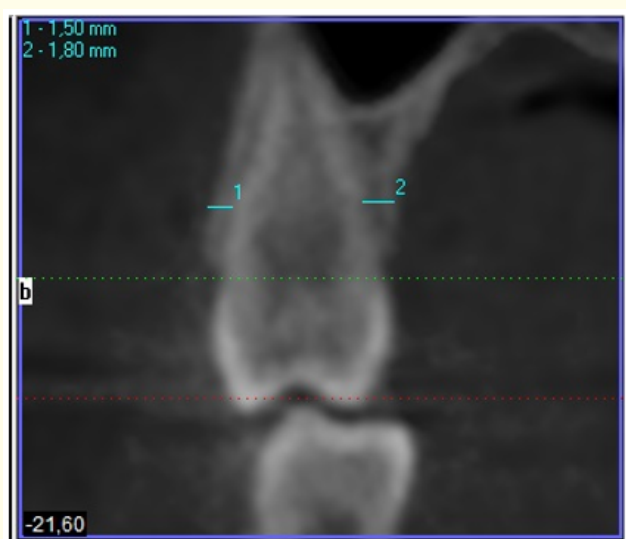


Figure 1: X-ray (tomographic) of the maxillary first premolar with the CT (1 - vestibular alveolar wall, 2 - oral alveolar wall).

After that, the results were measured and amplitude-time indices evaluated with the help of a computer program “Diastom” (Medass, Russia). The following indices were calculated automatically: rheography index (RI) which shows blood filling level of periodontium tissues, vascular tone index (VT), peripheral resistance index (PRI), vessel wall elasticity index (EI) and impedance index (II) (Figure 2).

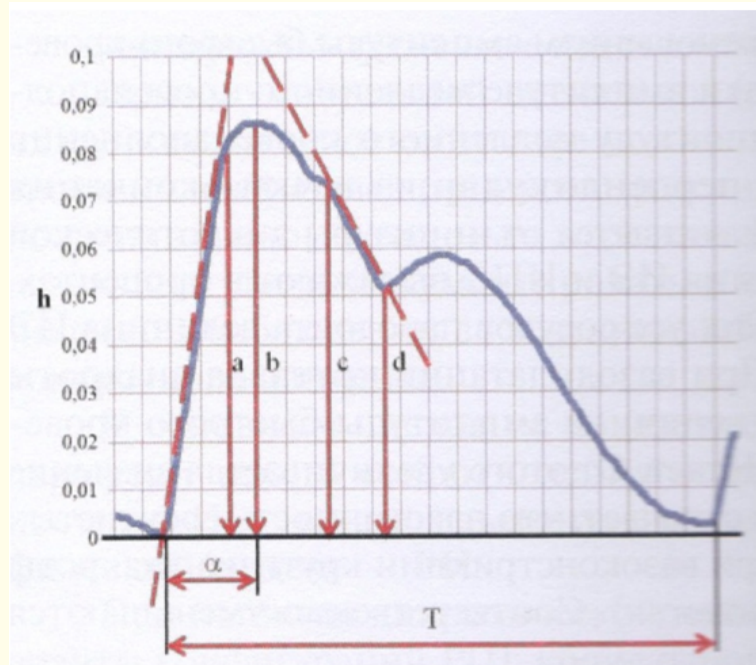


Figure 2: Reoperiodontogram amplitude-time scheme: a - fast blood filling amplitude, b - main amplitude, c - slow blood filling amplitude, d - dicrotic wave incisure amplitude, a - fast blood filling time (sec), T - pulse wave time.

The data was statistically processed. Line-type trend was used to process the graphic material.

Results and Discussion

Periodontium hemodynamics in the maxillary lateral teeth was studied, the results are shown in table 1.

Index Treatment stage	RI (Om)	VT (%)	PRI (%)	EI (%)
Before the treatment	0,36 ± 0,13	25,59 ± 2,6	92,48 ± 14,17	90,31 ± 13,43
NiTi 0,12"	0,38 ± 0,01	31,22 ± 1,34	113,79 ± 10,2	214,94 ± 10,82
NiTi 0,14"	0,13 ± 0,007	20,59 ± 0,82	201,4 ± 0,86	56,64 ± 1,19
NiTi 0,16"	0,22 ± 0,01	9,52 ± 0,43	77,65 ± 3,88	10,69 ± 0,42
NiTi 0,16 x 0,22"	0,1 ± 0,008	11,7 ± 0,38	30,02 ± 1,38	32,52 ± 1,11
NiTi 0,17 x 0,25"	0,67 ± 0,005	14,74 ± 0,79	144,54 ± 3,51	107,29 ± 2,06
Average norm	0,01 - 0,1	13 - 15	80 - 90	70 - 80

Table 1: Focusing reoperiodontography average indices for orthodontic patients with gradual wire change on fixed appliances.

Rheography index (RI) shows the periodontium blood-filling intensity. It is directly connected with the main amplitude. The higher the reoperiodontogram amplitude, the more intense the blood-filling. Tetrapolar method shows the RI norm within 0,01 - 0,1 Om (Figure 3).

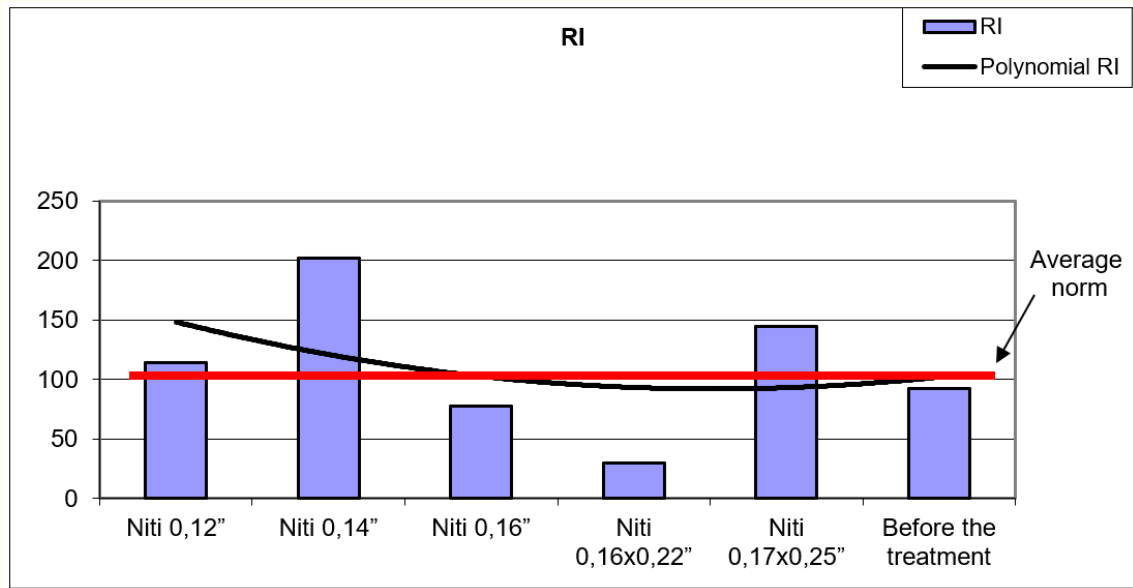


Figure 3: Rheography index changes (Om) in focusing reoperiodontography for orthodontic patients with gradual wire change on fixed appliances as compared to average norm. Polynomial trend line is used to indicate alternating rising and falling values. It is useful when analyzing a large amount of unstable value data.

The patients with malocclusion examined in the study had the rheography index (RI) increased 3.6 times at the start of the treatment (Figure 4).

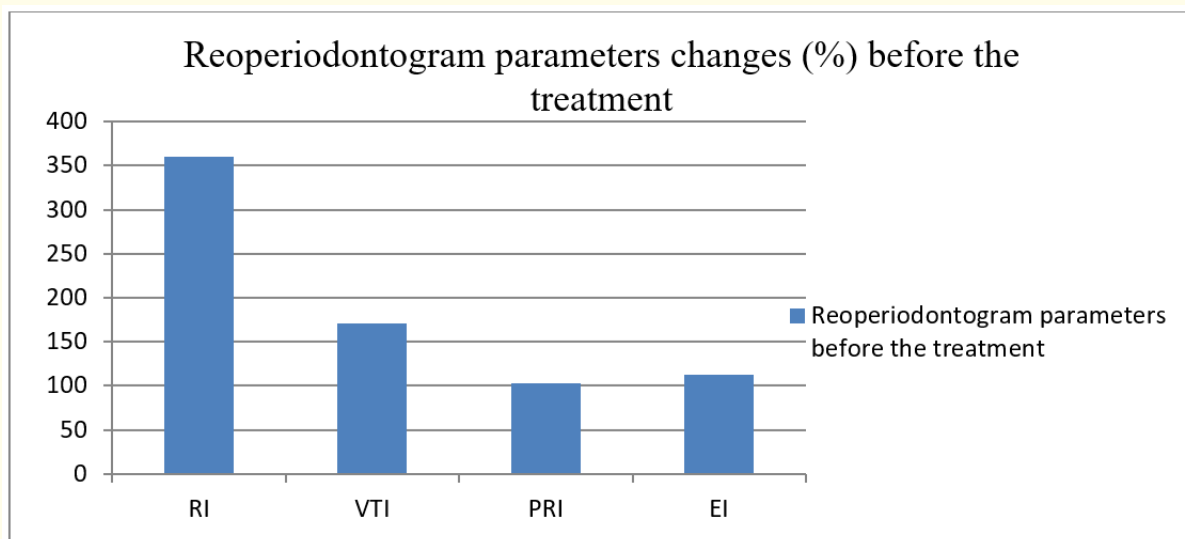


Figure 4: Focusing reoperiodontography parameters changes (%) before the orthodontic treatment as compared to the average norm (100%).

The blood vessel tone is indicated by the peripheral resistance index (PRI), as the peripheral resistance depends on the blood vessels opening: the narrower they are, the higher the resistance. It is calculated as the ratio of diastolic wave incisures amplitude to fast blood filling amplitude (Figure 2). Before the wire fixation the PRI was increased by 2,7% (Figure 5). This index is useful when identifying the blood vessels tone and their functional state.

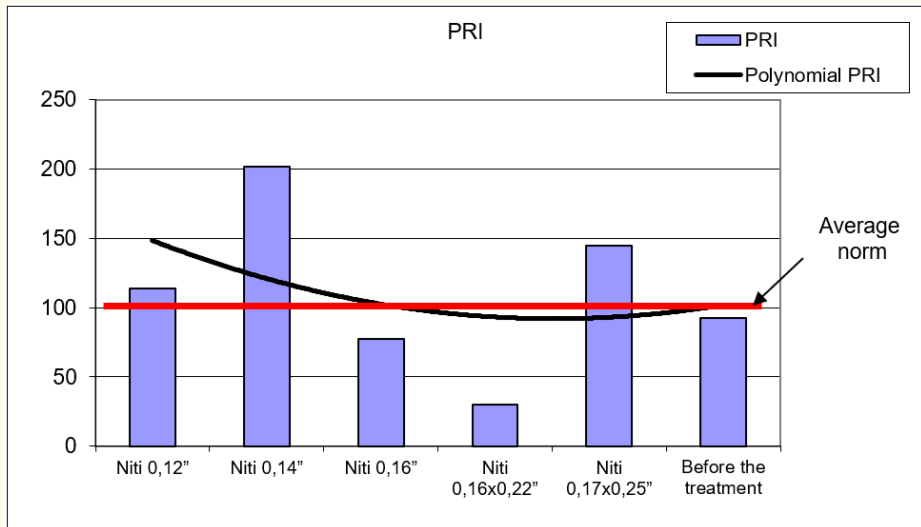


Figure 5: Peripheral resistance index (PRI) changes (%) in focusing reperiodontography for orthodontic patients with gradual wire change on fixed appliances as compared to average norm (100%). Polynomial trend line is used to indicate alternating rising and falling values. It is useful when analyzing a large amount of unstable value data.

Elasticity index (EI) is calculated as the ratio of fast blood filling amplitude to slow blood vessel amplitude. The higher this index is as compared to norm, the more increased is the elasticity of blood vessel walls. The initial value was increased by 12,8% (Figure 6).

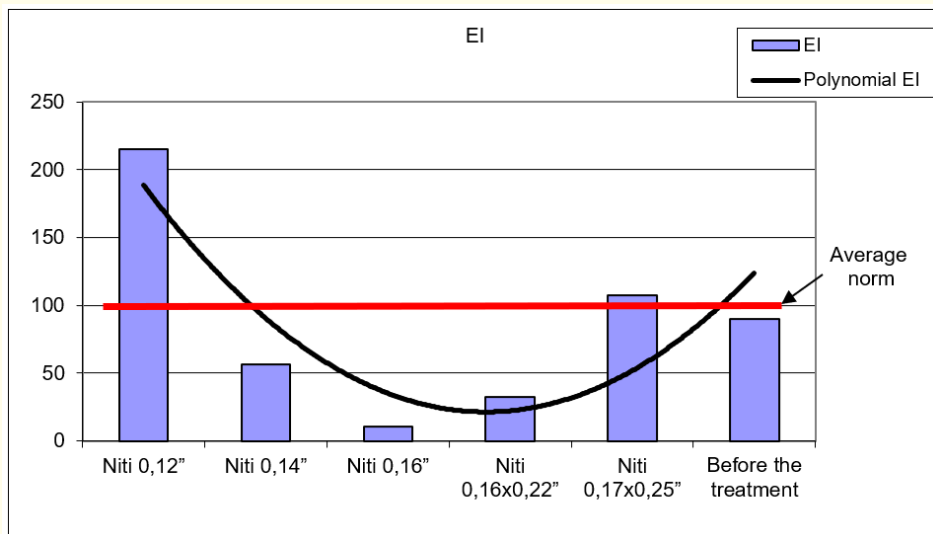


Figure 6: Elasticity Index (EI) changes (%) in focusing reperiodontography in focusing reperiodontography for orthodontic patients with gradual wire change on fixed appliances as compared to average norm (100%). Polynomial trend line is used to indicate alternating rising and falling values. It is useful when analyzing a large amount of unstable value data.

It is important to mention the PRI and EI indices are inversely related. With the increase of PRI, EI decreases, and vice versa. The physiological characteristic of the indices is the following: at vasoconstriction, the blood vessel tone increases, while the elasticity decreases.

Vascular tone index (VT) is calculated as the ratio of maximum pulse curve lift time to this pulse curve time period. This parameter depends on the physiological state of periodontium vessel walls. The initial vascular tone index was increased by 70,6% or 1.7 times (Figure 7).

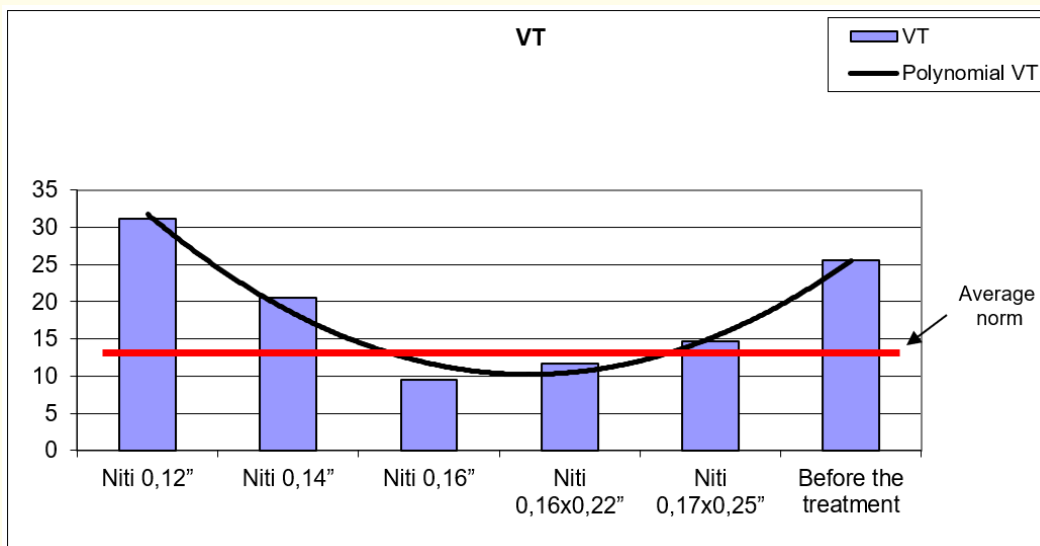


Figure 7: Vascular tone index (VT) changes (%) in focusing reperiodontography in focusing reperiodontography for orthodontic patients with gradual wire change on fixed appliances as compared to average norm (100%). Polynomial trend line is used to indicate alternating rising and falling values. It is useful when analyzing a large amount of unstable value data.

The patients with malocclusion examined in the study had the rheography index (RI) increased 3.8 times after the 0.12 wire was applied.

Peripheral resistance index was increased by 26,4%, vascular tone index (VT) was increased by 8,1%, which indicates the vasoconstriction, while the Elasticity index (EI) increased 2,7 times (Figure 8).

After the 0.14 wire was applied, the rheography index (RI) increased 1.3 times. Peripheral resistance index (PRI) increased 2.2 times, vascular tone index (VT) increased by 37,3%, while the Elasticity index (EI) decreased by 29,2% (Figure 8).

After the 0.16 wire was applied, the rheography index (RI) increased 2.2 times. Peripheral resistance index (PRI) decreased by 13.7%, vascular tone index (VT) decreased by 36,5%, Elasticity index (EI) decreased 7,5 times (Figure 8).

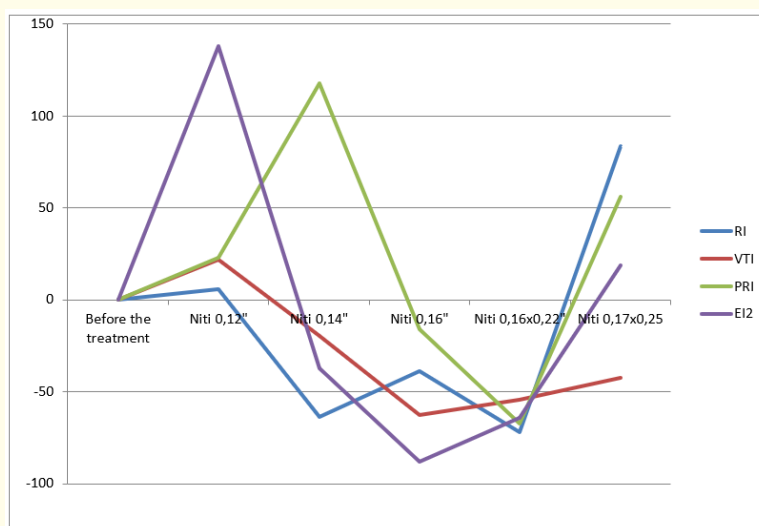


Figure 8: Parameter changes (%) in focusing reperiodontography for orthodontic patients with gradual wire change on fixed appliances as compared with the initial values (100%).

After the NiTi 0.16 x 0.22 wire was applied, the rheography index (RI) returned to its norm. Peripheral resistance index (PRI) was decreased by 66.6%, vascular tone index (VT) decreased by 22%, Elasticity index (EI) decreased 2,5 times (Figure 8).

After the NiTi 0.17 x 0.25 wire was applied, the rheography index (RI) increased 6.7 times. Peripheral resistance index (PRI) increased by 60.6%, vascular tone index (VT) was within the average norm, Elasticity index (EI) increased by 33.7% (Figure 8).

The focusing reperiodontography parameters in orthodontic patients were registered after 30 days from every new wire size applied. The data obtained is shown in table 2.

Index Treatment stage	RI (Om)	VT (%)	PRI (%)	EI (%)
NiTi 0,12"	0,16 ± 0,01	12,3 ± 0,42	31,5 ± 1,8	316,1 ± 10,8
NiTi 0,14"	0,16 ± 0,005	17,4 ± 0,5	103,1 ± 3,3	54,8 ± 3,3
NiTi 0,16"	0,12 ± 0,004	12,4 ± 0,6	91,6 ± 1,6	21,6 ± 1,3
NiTi 0,16 x 0,22"	0,23 ± 0,015	22,9 ± 0,8	97,93 ± 3,01	59,2 ± 2,2
NiTi 0,17 x 0,25"	0,05 ± 0,006	7,53 ± 0,6	101,7 ± 0,9	104,5 ± 3,5
Average norm	0,01 - 0,1	13 - 15	80 - 90	70 - 80

Table 2: Average figures of focusing reperiodontography for orthodontic patients 30 days after the wires fixation.

After 30 days application of NiTi 0.12, the rheography index (RI) increased by 60% as compared to the average norm. Peripheral resistance index decreased by 64%, vascular tone index (VT) decreased by 18% which indicates the vasodilatation; Elasticity index (EI) increased 3.9 times (Figure 9-13).

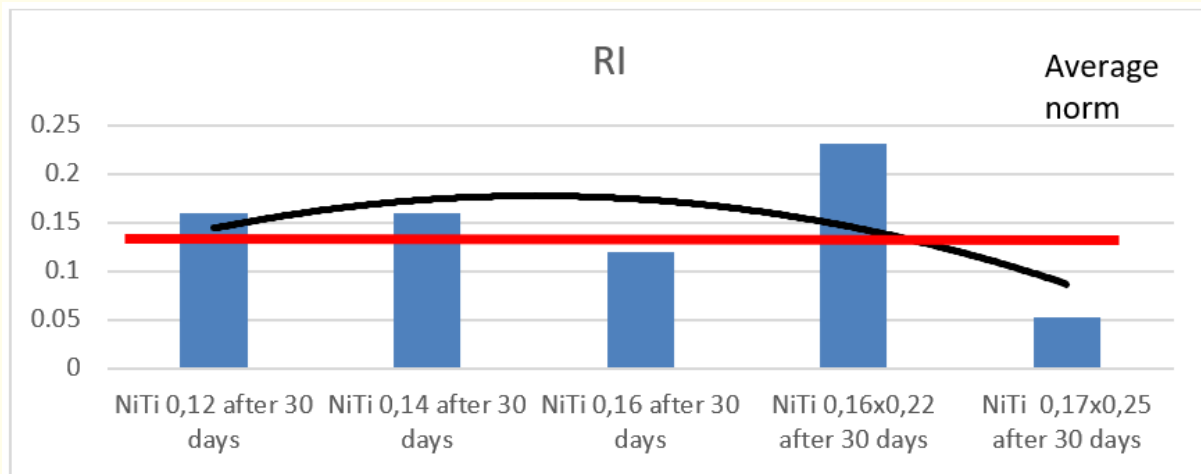


Figure 9: Rheography index changes (Om) in focusing reperiodontography for orthodontic patients after 30 days of gradual wire change on fixed appliances as compared to initial results.

After 30 days application of NiTi 0.14, the rheography index (RI) increased by 60%. Peripheral resistance index increased by 14.5%, vascular tone index (VT) increased by 16%, Elasticity index (EI) decreased by 31.5% (Figure 9-13).

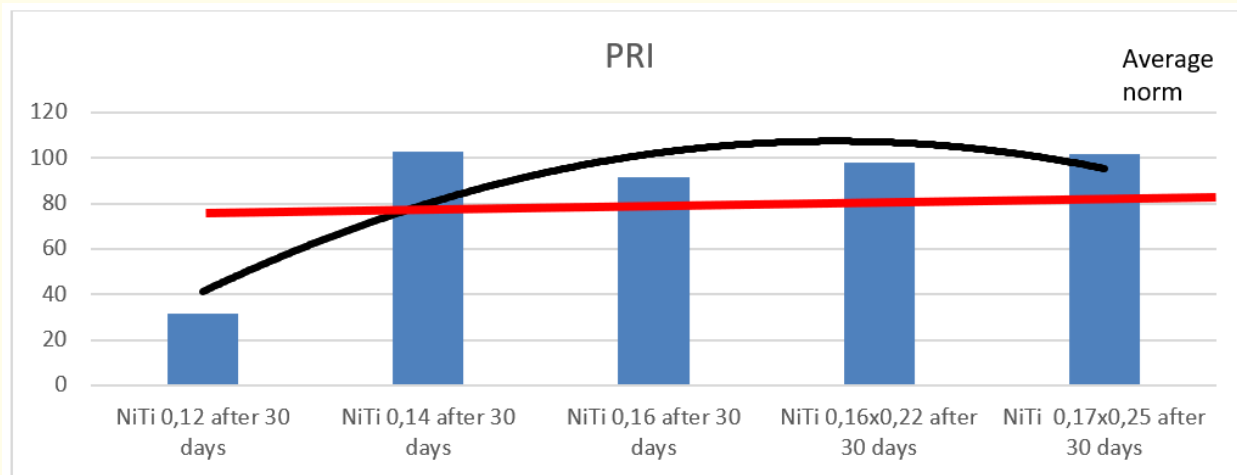


Figure 10: Peripheral resistance index (PRI) changes (%) in focusing reperiodontography for orthodontic patients after 30 days of gradual wire change on fixed appliances as compared to initial results (100%).

After application of NiTi 0.16, the rheography index (RI) increased by 20%. Peripheral resistance index remained within the norm, vascular tone index (VT) decreased by 17.4%, Elasticity index (EI) decreased by 73% (Figure 9-13).

After 30 days application of NiTi 0.16 x 0.22, the rheography index (RI) increased 2.3 times. Peripheral resistance index increased by 8.8%, vascular tone index (VT) increased by 34.4%, Elasticity index (EI) decreased by 26% (Figure 9-13).

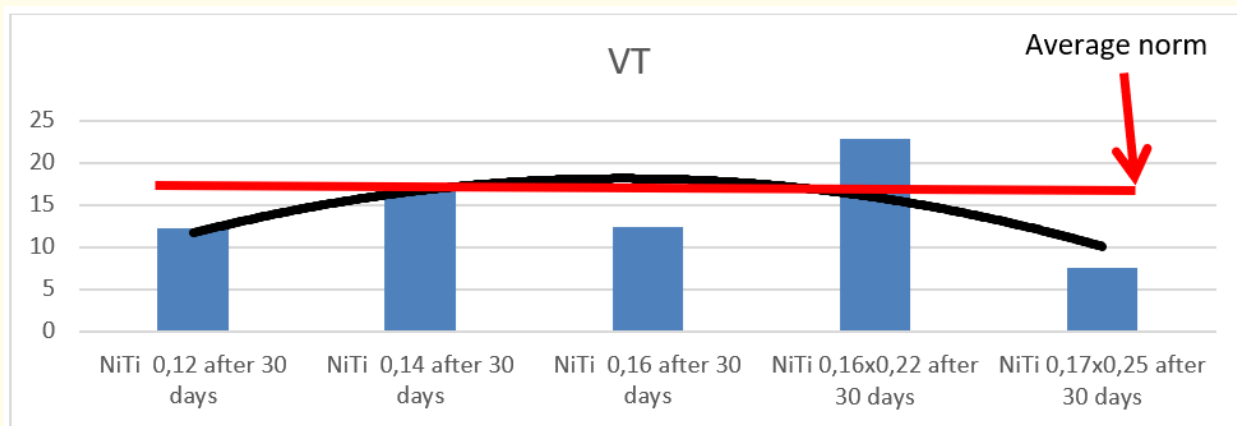


Figure 11: Vascular tone (VT) index changes (%) in focusing reperiodontography for orthodontic patients after 30 days of gradual wire change on fixed appliances as compared to initial results (100%).

After 30 days application of NiTi 0.17 x 0.25, the rheography index (RI) returned to its norm. Peripheral resistance index increased by 13%, vascular tone index (VT) decreased by 49.8%, Elasticity index (EI) increased by 30.6% (Figure 9-13).

Therefore, the initial research of the maxillary lateral teeth periodontium state in patients with malocclusion with the help of focusing reoperiodontography showed that the rheography index (RI) which indicates periodontium vessels blood-filling degree, vascular tone index (VT), peripheral resistance index (PRI), elasticity index (EI) were increased as compared to the average norm.

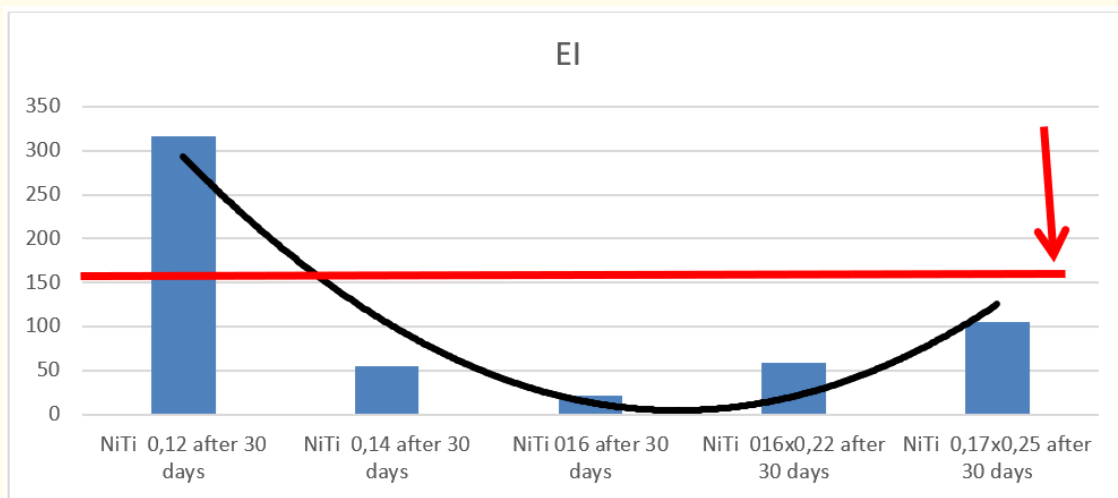


Figure 12: Elasticity index (EI) changes (%) in focusing reoperiodontography for orthodontic patients after 30 days of gradual wire change on fixed appliances as compared to initial results (100%).

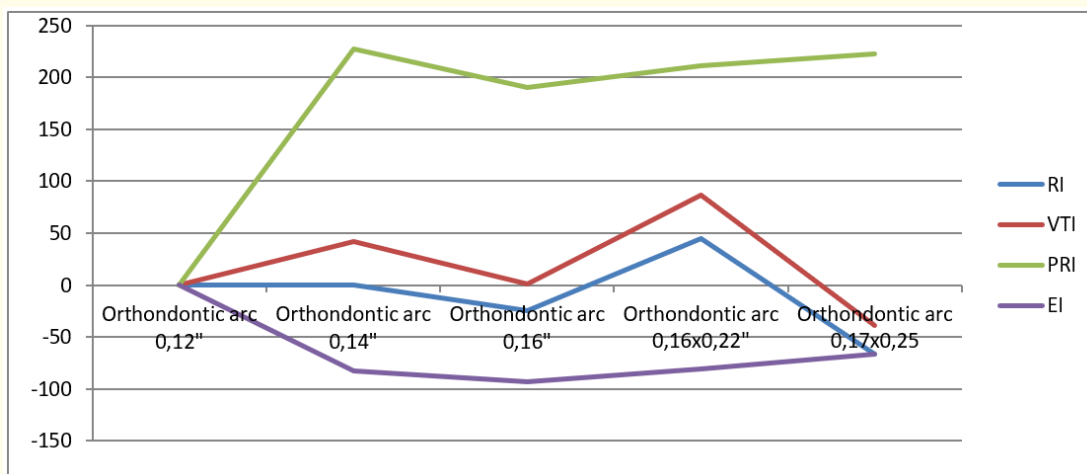


Figure 13: Parameter changes (%) in focusing reoperiodontography for orthodontic patients after 30 days of gradual wire change on fixed appliances as compared to the initial values (100%).

Rheography index (RI) increased to a greater extent (3.6 times). The initial vascular tone index (VT) increased by 1.7 times and depends on the periodontium vessel walls physiological state. The initial elasticity index (EI) increased by 12.8% and indicates the overall increase of vessel walls elasticity. Before the fixation the peripheral resistance index (PRI) was increased by 2.7% and is informative as the vessel tone and functional state indicator.

The comparative analysis of the focusing reperiodontography parameters obtained at the initial wire change stage and 30 days after showed the rheography index (RI) to decrease by 42.1% after 30 days of NiTi 0.12 appliance and above the average norm by 60%. After 30 days of applying NiTi 0.14 the rheography index increased by 23%, or 60% difference from the norm. After the NiTi 0.16 appliance RI decreased by 45.5%, which was 20% higher than the norm. After the NiTi 0,16 x 0,22 the periodontium vessels blood filling degree changed to a larger extent (131%) which resulted in the correlation with the norm as well (131%). After 30 days of NiTi 0,17 x 0,25 appliance the blood filling degree decreased by 92.1% which comprised 47% from the norm.

Vascular tone index (VT) decreased by 61.6% and 16.5% after 30 days appliance of NiTi 0.12 and 0.14 respectively; which is lower than the norm by 18%. The second wire increased the norm discrepancy by 16%. NiTi 0.16 increased the vessel tone by 30.3%, which is lower than the norm by 17.4%. NiTi 0,16 x 0,22 increased the index by 95.7% which was 52.7% norm discrepancy. NiTi 0,17 x 0,25 decreased the vessel tone by 48,8% which was lower than the norm by 49.8%.

The peripheral resistance index (PRI) decreased by 72.3% and 48.8% after 30 days of NiTi 0.12 and 0.14 respectively, which meant 64% lower than norm for the first figure and 14.6% higher than norm for the second. NiTi 0,16 increased the PRI by 179%, and the norm discrepancy increased by 8,8%. NiTi 0,16 x 0,22 increased the parameter 3.2 times which complies with the average norm. After 30 days of NiTi 0,17 x 0,25 the PRI decreased by 39.4% which is higher than the norm by 13,0%.

After 30 days of the NiTi 0.12 appliance the elasticity index (EI) increased by 47% and was 3.9 times higher than the norm. After 30 days of NiTi 0.14 appliance the parameter decreased by 3.3%, which indicated 31.5% norm discrepancy. NiTi 0.16 increased the vessel walls elasticity by 102.0%, the norm discrepancy was 73.0%. NiTi 0,16 x 0,22 increased the parameter by 82% which was 26% lower than the norm. NiTi 0,17 x 0,25 decreased the parameter by 2.6% which was 30.6% higher than the norm.

Conclusion

1. The periodontium functional state of maxillary lateral teeth was studied in patients with malocclusion with the help of focusing reperiodontography. Rheography index (RI) which indicates periodontium vessels blood-filling degree, vascular tone index (VT), peripheral resistance index (PRI) and vessel wall elasticity index (EI) were increased if compared to the average norm. The initial EI increased by 12.8% and indicates the overall increase of the vessel walls elasticity. Before the wire appliance the PRI was increased by 2.7%. This parameter is especially informative as the vessel tone and functional state indicator.
2. After 30 days of subsequent NiTi (0,12; 0,14; 0,16; 0,16 x 0,22; 0,17 x 0,25) wires application in patients with malocclusion the rheography index (RI) which indicates periodontium vessels blood-filling degree, vessel tone index (VT), peripheral resistance index (PRI) and blood wall elasticity index (EI) were increased as compared to the norm.
3. The rheography index (RI) increased to a greater extent (3.6 times) indicating periodontium vessels blood-filling intensity and is connected with the main RPG amplitude. The bigger the amplitude, the higher tissue blood-filling. The initial vascular tone index (VT) was increased 1.7 times and depends on the periodontium vessel walls physiological state.
4. All the reperiodontography changes described during the orthodontic treatment and subsequent wire appliance support the notion of local response to the forces applied being physiology functioning law.

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