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Wykorzystanie kamery termowizyjnej nowej generacji do oceny wpływu sił ortodontycznych na dziąsło

The application of a new-generation thermal imaging camera for the assessment of hemodynamic changes in gingiva during orthodontic treatment

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Abstract

Introduction. One of the most interesting modern methods of assessing microcirculation is thermovisiual examination. Thermovision cameras are commonly used in general medicine. As the periodontium is one of the most vascularized tissues in the human body, the application of high-sensitivity thermovision cameras may allow for noninvasive assessment and early detection of pathological changes in the gingiva by giving a complete picture of the situation.
Aim. The aim of the study was to assess hemodynamic changes in the gingiva during orthodontic treatment with the use of a new-generation thermal imaging camera.
Material and methods. Three patients aged 10 to 13 years under orthodontic treatment with fixed appliances were studied. The thermographic examination with a high-sensitivity X6580sc camera concerned upper incisors with clinically healthy periodontium.
Results. Based on the examination and data analysis it was observed that in measurements taken after about 5 minutes from initial examination there were no changes in the mean temperature value. However after about 20 minutes the change in the mean temperature value was 1.5°C which may indivate hemodynamic changes in the gingiva.
Conclusion. The thermographic examination revealed changes in the blood flow in the gingiva after application of orthodontic force. Using this method of examination may help monitor transitional inflammation processes in the gingiva during a therapy with fixed appliances.

Keywords: termography, orthodontic treatment, blood flow in gingiva.

Streszczenie

Wstęp. Jedną z nowoczesnych metod oceny mikrokrążenia, zasługującą na szczególną uwagę, jest badanie termowizyjne. W medycynie ogólnej kamery termowizyjne mają szerokie zastosowanie. Wydaje się, że szersze zastosowanie w stomatologii umożliwiłoby dokładniejszą ocenę mikrokrążenia w jamie ustnej, ale zastosowanie tej metody jest wciąż niedocenione. Biorąc pod uwagę fakt, iż przyzębie jest najbardziej unaczynioną tkanką w ciele człowieka, zastosowanie kamery termowizyjnej wysokiej czułości mogłoby pozwolić na nieinwazyjną ocenę i wczesne wykrycie zmian patologicznych w obrębie dziąseł, dając pełen obraz zmian.
Cel. Celem pracy było wykorzystanie kamery termowizyjnej nowej generacji do oceny wpływu sił ortodontycznych na ukrwienie dziąsła.
Materiał i metody. Troje pacjentów w wieku od 10 do 13 lat zostało objętych badaniem. Wszyscy pacjenci byli w trakcie leczenia ortodontycznego. Badanie termowizyjne dotyczyło górnych siekaczy z klinicznie zdrowym przyzębiem. Do badania termowizyjnego dziąsła zastosowano kamerę wysokiej czułości X6580sc.
Wyniki. W oparciu o przeprowadzone badania termowizyjne i analizę danych można stwierdzić, iż w pomiarach przeprowadzonych po około 5 minutach po badaniu początkowym nie wykazano zmian w średniej wartości temperatury. Natomiast po około 20 minutach zmiana średniej wartości temperatury wynosiła 1,5°C co świadczy o zmianach hemodynamicznych w dziąśle.
Wnioski. Badanie termograficzne wykazało zmiany w przepływie krwi w obrębie dziąsła bezpośrednio po zastosowaniu siły ortodontycznej. Badanie termograficzne może być pomocne w monitorowaniu przejściowego procesu zapalnego w dziąśle w trakcie terapii przy pomocy stałych aparatów ortodontycznych.

Słowa kluczowe: termografia, leczenie ortodontyczne, przepływ krwi w dziąsłach.

Introduction

The thermovision examination is one of the modern methods of assessment of the microcirculation in human body requiring particular attention. Thermography is entirely noninvasive and safe diagnostic method allowing for two-dimensional

visualization of the examined tissue or organ. The measurement is performed in real time and the results of the research e.g. the temperature range and their values are known at once [1–4].

The action of the thermographic camera is based on the invisible infrared radiation phenomenon. Each body with the temperature higher than the absolute zero is a source of the infrared radiation and its intensity depends on the temperature and the surface features of the body. The camera registers the infrared radiation emitted from the certain object. The radiation goes through the lens and concentrates on the detector similarly to the visible radiation observed on the film of the ordinary camera. Each camera has a matrix of the detectors and the co-operated system of searching images (point after point and line after line). The detector creates a kind of the electric signal on the base of read-out of pixels on the detector matrix. The electric signal will be created relatively to the intensity of the emitted infrared radiation. The signal is changed into digital. The examination through the registration of the differences in the infrared radiation of certain object allows for the creation of the temperature picture (thermogram). That kind of images become more and more accurate as the methods of achieving the high resolution develops [1, 2]. In general medicine the thermovision camera has a wide application in the measurements of the blood supply in skin after burns, and in certain pathologic illnesses e.g. cancers and sclerodermas, in plastic surgery, in the diagnosis of vascular illnesses and in ophthalmology and urology [5–9]. It seems that in dentistry the application of that method for wide scale could allow more accurate assessment of the microcirculation in oral cavity and the usefulness is still unappreciated [10–14]. Taking into account the fact that periodontium is one of the most vascularized tissues in the human body, the application of thermovision camera of high sensitivity could allow for the noninvasive assessment and early detection of pathological changes in gingiva giving complete picture of that changes. In Polish literature there are very few articles about practical application of that method [11], and according to our knowledge there are no studies about monitoring the changes in blood supply in gingiva during the treatment of malocclusion with the fixed appliances and especially in the first phase of orthodontic treatment called “leveling”. It worth pointing that the orthodontic treatment is reestablishing the proper function in stomatognathic system but on the other hand may result the destruction of teeth structures and periodontium. One of the unexpected consequences of orthodontic tooth movement may be the destruction of periodontal tissues and root resorption [15, 16]. The action of the fixed orthodontic appliances is based on application of two kinds of the orthodontic forces: the continuous and the interrupted orthodontic force. It was hypothesized that the interrupted forces may be more advantageous in clinical setting because during the period of force declining the reorganization of periodontium and repair can take place [15, 16].

Aim

The aim of the study was the initial assessment of hemodynamic changes in gingiva during the orthodontic treatment with using new generation of thermal imaging camera.

Material and methods

The investigations were carried out on the group of 3 patients aged between 10 and 13 years old in a general good health. The patients were during the orthodontic treatment. The thermovision examination were performed in the area of the upper incisors, the exanimated teeth were without caries

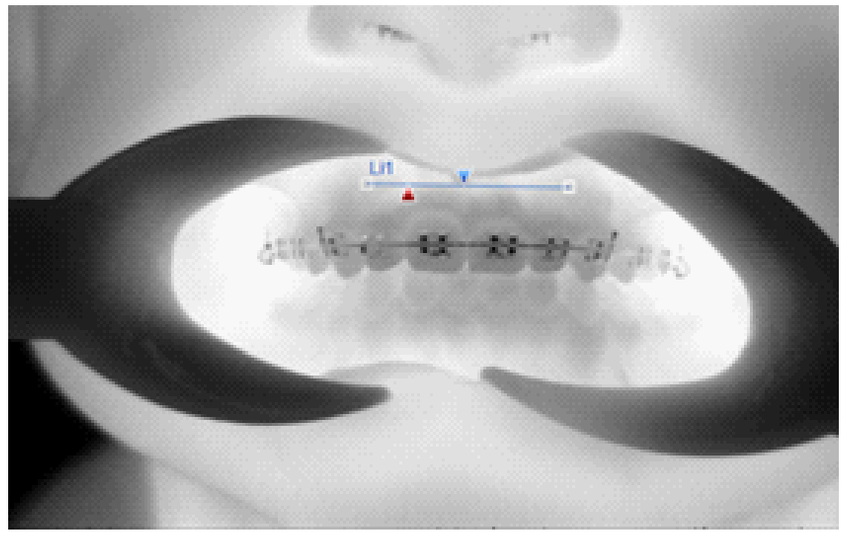

Figure 1. The way of conducting of the measurements
Rycina 1. *Metoda przeprowadzenia pomiarów*

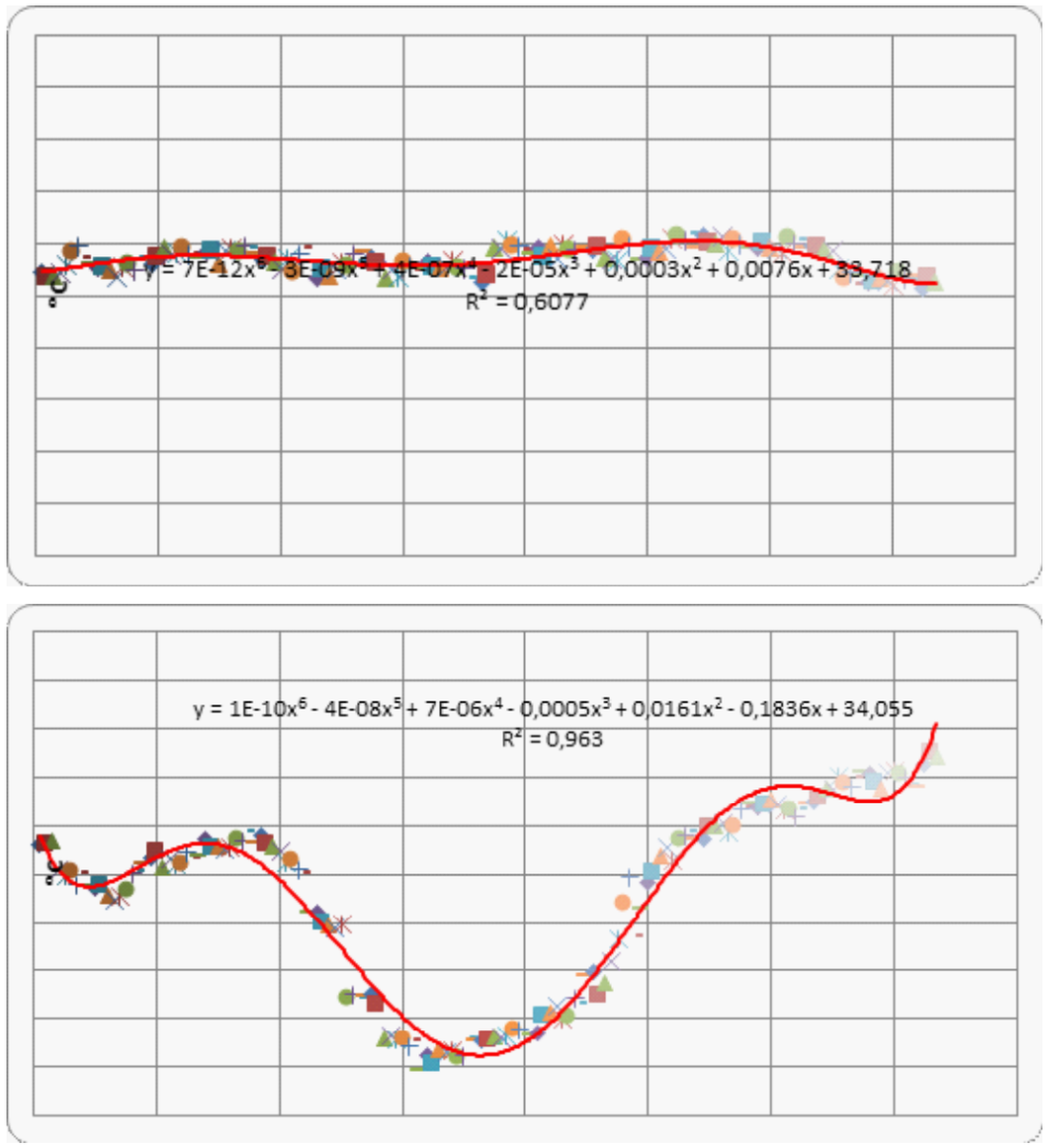

Figure 2. Range of the temperature on the surface of the gingiva in patient No. 1, a – with 0.016/22 NiTi wire – first examination, b – conducted in 5 minutes after application of 0.016/22 SS wire

Rycina 2. *Rozkład temperatury na powierzchni dziąsła u pacjenta nr 1, a – z łukiem 0,016/22 NiTI – pierwsze badanie, b – przeprowadzone po 5 minutach po założeniu łuku 0,016/22 SS*

and cavities with the clinically healthy periodontium (lack of a pathological gingival pockets/periodontal, a tooth mobility, mSBI index < 10%, with a very good oral hygiene (API = 10%).

The thermovision examination was performer with the usage of a thermovision camera TermaCam X6580sc with cooling (Flit System AB, Sweden), with the lens MW 50 mm 2.0, 640x512. The frequency of recorded sequences amounted 25 fps, and the time of integration amounted 935 μs. The way of conducting of the examination is shown in **Figure 1**.

The examination was conducted in the air temperature 20°C, the coefficient of emission amounted 0,95 and the sensitivity of emission < 20mK (< 0,002°C grade). The examination was carried out 1 minute after opening of the mouth. The thermovision camera was hold on the tripod 20 centimeters from oral cavity.

For the elimination of external factors that may modulate the results, the patients couldn't eat or drink one hour before the examination. The patients were in a sitting position. The examination was approved by Bioethical Committee of Medical University of Gdansk (NKBBN/104/20B).

Results

The analysis of the data obtained from the thermovision examination is presented below.

Patient No 1. is a boy at the age of 13 during the orthodontic treatment with the fixed orthodontic appliance at the final stage of levelling. In this patients two examinations were conducted – one with the 16/22 NiTi wire, and the second examina-

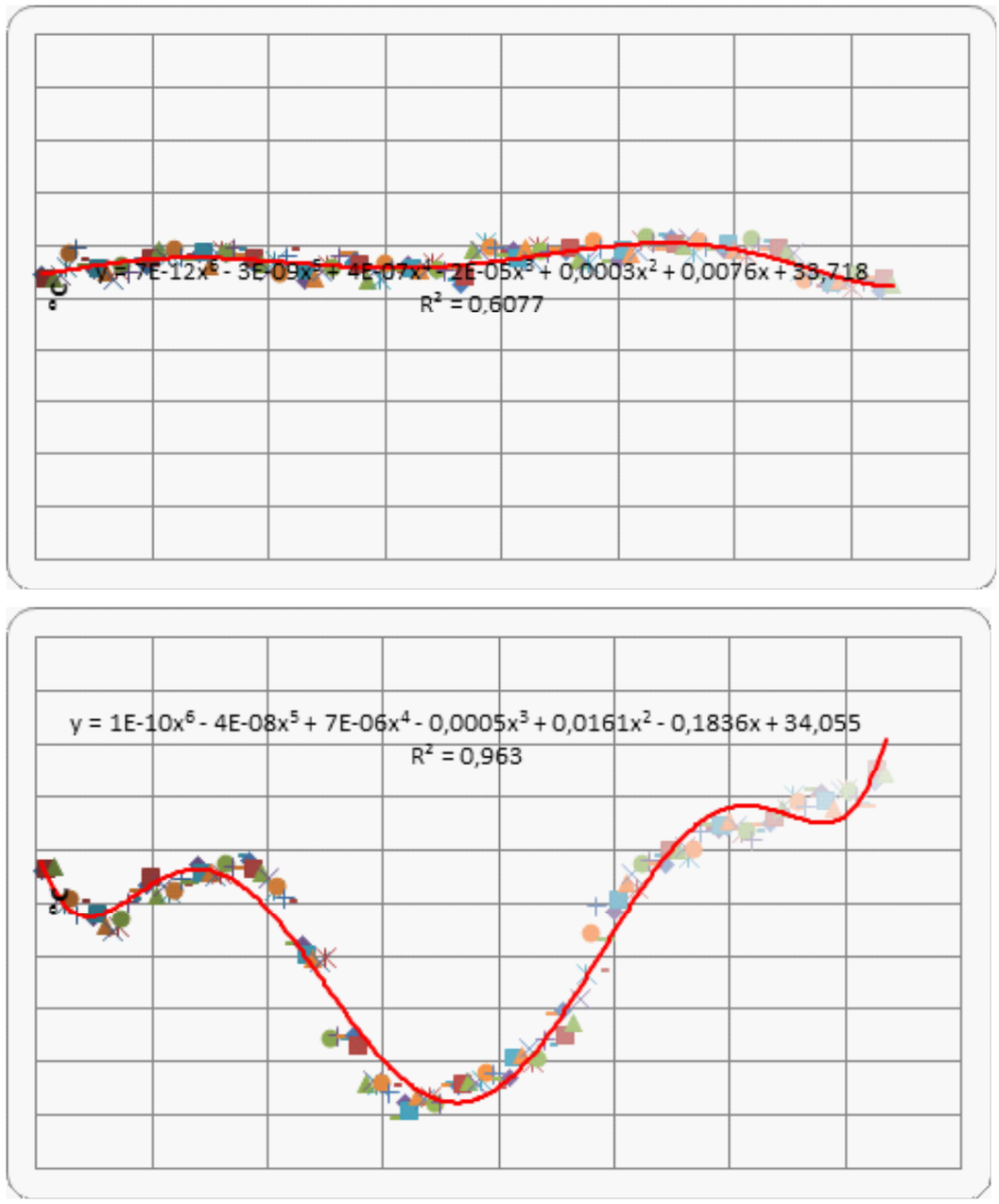

Figure 3. Range of the temperature on the surface of the gingiva in patient No. 2, a – after application of 0.012 NiTi wire – first examination, b – 5 minutes after application of 0.012 NiTi wire

Rycina 3. *Rozkład temperatury na powierzchni dziąsła u pacjenta nr 2, a – z łukiem 0,012 NiTI – pierwsze badanie, b – przeprowadzone po 5 minutach po założeniu łuku 0,012 NiTi*

tion directly (about 5 minutes) after the application of the 16/22 SS wire.

The range of the temperature in the examined area of the gingiva in the first examination of the patient no. 1 with 16/22 NiTi wire (**Figure 2a**) showed: the minimal temperature: 34.1°C, max: 35.7°C, the mean temp. 34.9°C, the range of changes: 1.6°C, the standard deviation: 0.3°C. In the second examination of the same patients conducted 5 minutes after the application of the 16/22SS wire the fallowing results were obtained: the minimal temperature: 33.9°C, max: 35.6°C, the mean temp. 34.9°C, the range of changes: 1.7°C, the standard deviation: 0.4°C (**Figure 2b**). The analysis of the results allows to state that in spite of the higher differentiation of the temperature range in the examined area after 5 minutes in relation to the initial examination, the mean values of temperature in both situations were the same. Patient no. 2 is a girl at the age of 11 in the day of the bonding of the fixed orthodontic appliance. The first examination was done just after bonding of the brackets, and the second examination directly (5 minutes) after the application of 0.012 NiTi wire. Range of the temperature on the surface of the gingiva in patient no. 2 in the first examination without orthodontic wire (**Figure 3a**) was fallowing: the minimal temperature: 33.5°C, max: 34.1°C, the mean temp.

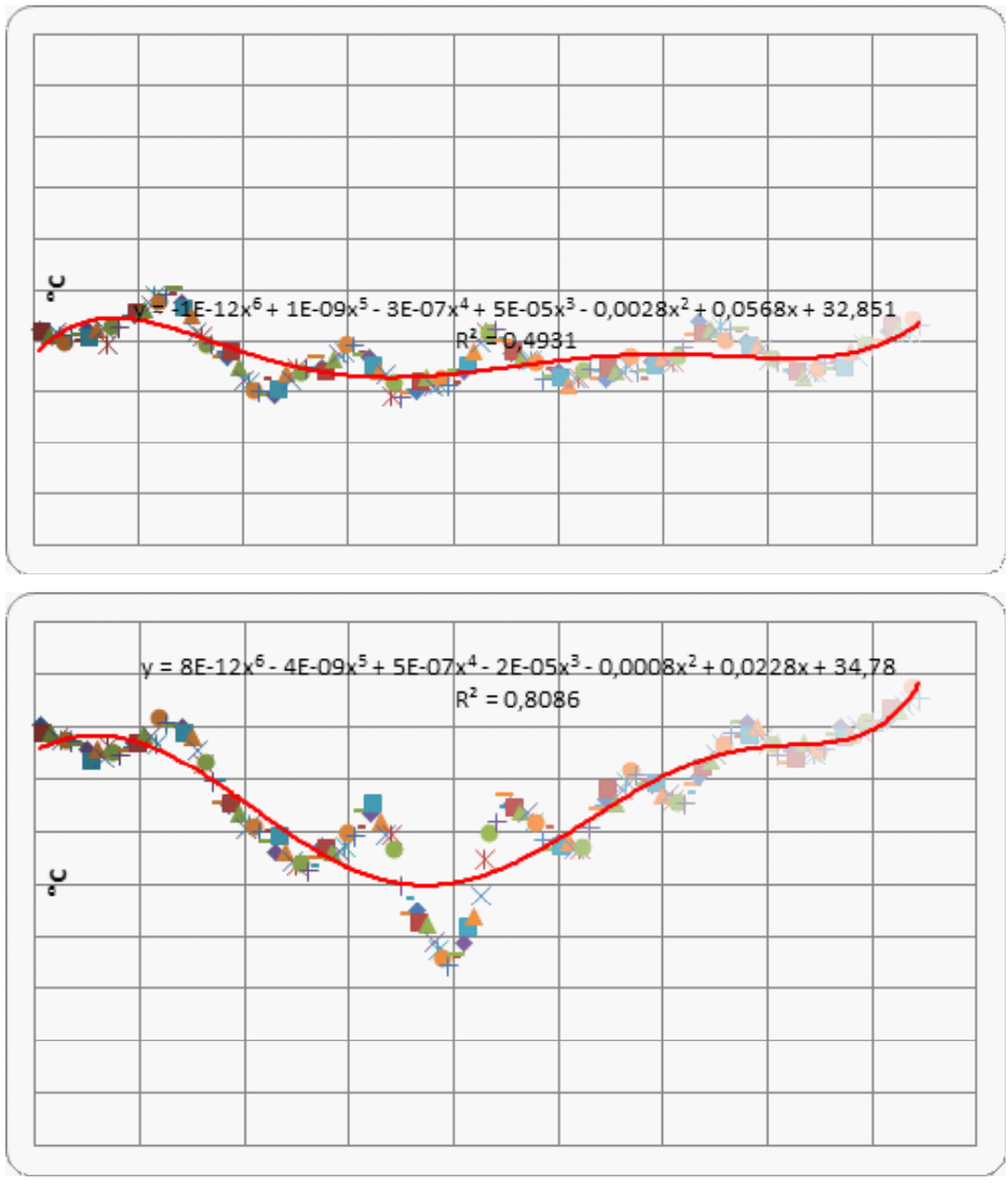

Figure 4. Range of the temperature on the surface of the gingiva in patient No. 3, a – after deligaturing of 0.016 NiTi wire, b – 20 minutes after application of 0.016/22 NiTi wire

Rycina 4. *Rozkład temperatury na powierzchni dziąsła u pacjenta nr. 3, a – po odligaturowaniu łuku 0016 NiTi, b – przeprowadzone po 20 minutach po założeniu łuku 0,016/22 NiTi*

34.8°C, the range of changes: 0.6°C, the standard deviation: 0.1°C, in the second examination with the wire 0.012 NiTi (**Figure 3b**) obtained: the min. temperature: 31.5°C, max: 34.8°C, the mean temperature was 34.7°C, the range of changes: 3.3°C, the standard deviation: 0.9°C.

Similarly, as with the results obtained for the patient no. 1, it can be stated that in spite of the higher differentiation of the temperature range in the examined area after 5 minutes in relation to the initial examination, the mean values of temperature in both situations were the same.

Patient no. 3 is a boy at the age of 10 under orthodontic treatment for the last 6 month. The first examination was conducted after deligaturing of 0.16 NiTi, the second examination 20 minutes after application of 16/22 NiTi wire. The range of the temperature on the surface of the gingiva in third patient in first examination after deligaturing of 0.016 NiTi wire as follws (**Figure 4a**): min. temperature: 32.4°C, max: 33.5°C, mean 32.9°C, the range of changes: 1.1°C, standard deviation: 0.2°C, and in 20 minutes after application of 16/22NiTi (**Figure 4b**) the fallowing data were obtained: min. temperature: 32.7°C, max: 35.4°C, mean 34.4°C, the range of changes: 2.7°C, standard deviation: 0.6°C. The analysis of the data it can be stated that higher differentiation of the range of the tempera-

ture in examined area were in 20 minutes after application of the wire. Comparing to the initial examination the mean value of the temperature in the examination in 20 minutes after application of the wire increased about 1.5°C.

Discussion

The examination of the blood perfusion in gingiva by usage of the thermovision camera is a noninvasive, highly sensitive and allows the monitoring of the hemodynamic changes in soft tissues. In dentistry the thermovision cameras may be widely used in many specialties e.g. in periodontology, monitoring of the inflammation in periodontium, in endodontics, dental materials [1, 2, 10–14]. Moreover, the device can be used in orthodontics for the assessment of the changes in periodontium during the orthodontic treatment.

During the orthodontic treatment in relations to the magnitude of the othodontic treatment the transitional inflamation take place that results in biochemical changes, and cellular changes in periodontuium. Proper methods of treatement and safe orthodontic forces are necessary to consider in relations to the clinical status and desired orthodontic tooth movement [15, 16]. In the literature there is lack of studies concerning the thermovision examinations in planning of the orthodontic treatment especially in adults with the application of different types of orthodontic devices.

The preliminary study and analysis of the results suggests that it is necessary to prolong the time between the examinations. The measurements conducted in 5 minutes from initial examination didn't reveal significant change in mean values of the temperatures. Exclusively after 20 minutes the change of the mean temperature value about 1.5°C was observed. higher differentiation of the range in the area of interests in 5 minutes after the initial examination may be results of the presence of the foreign body (bracket, wire), which initial temperature was different than inside the mouth.

The obtained results encourages the continuation of the study. The assessment of the hemodynamic changes in gingiva in different types of orthodontic appliances in future may help to work-out the algorithm of implementation of methods in clinical situations. It will also give the idea about the reversibility of changes in a time.

Conclusions

1. Thermographic examination reveal the changes in gingiva directly after the application of the orthodontic force.
2. The thermographic examination may be helpful in monitoring the transitional process.

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