DIAGNOSTIC OF MAXILLOFACIAL PATHOLOGY

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Abstract: This paper describes importance of use of modern temperature measuring equipment in diagnostic of maxillofacial pathology. Each change in the maxillofacial region of human body caused by tumour, inflammation or other disease typically causes small change in temperature on the skin of patient. In this paper, we will present preliminary study and suggest procedures how to detect these temperature changes with use of thermal imagining cameras.

Keywords: maxillofacial pathology, temperature measurements, diagnostic

1. INTRODUCTION

In this paper we would like to present results of the preliminary study in the use of thermal imagers in diagnostic of maxillofacial pathology. Thermal imagers are non-contact thermometers, which measure the surface temperature of objects. Each body that has a temperature above absolute zero temperature (0 K) radiates a certain thermal energy. Based on the Planck law, if we know the wavelength of electromagnetic radiation and surface emissivity, we can measure the temperature of the surface of a particular object. Because there is no contact between the surface of the measured object and measuring instrument, there is no additional influence on the measuring object by the used measuring equipment.

Regarding the spectral region, human skin is a black body radiator with an emissivity factor of 0,98 and is therefore a perfect emitter of infrared radiation at room temperature. Infrared thermal cameras generate images based on the amount of heat dissipated at the surface by infrared radiation. Human heat energy is transferred to the environment via conduction, convection, radiation and sweat evaporation, [1].

Cancer detection was a high priority subject for usage of thermal imagers in medicine. Hopes that this new technique would be a tool for screening breast cancer provided the motivation to develop detectors and procedures. Many centres across Europe, the United States, and Japan became involved. In the United Kingdom, a British surgeon, K. Lloyd Williams showed that many tumours are hot and the hotter the tumour, the worse the prognosis. In the 1960s the first colour thermograms were produced. Mini-computers for image processing arrived in the mid- to late 1970s providing colour display, image analysis and, importantly, data and image storage. Image quality has dramatically improved with development of modern thermal imaging systems, which provide high speed images at high thermal and spatial resolution. Digital thermograms are now very different from the crude clinical images obtained almost 50 years ago. With the development of hardware, also the software for processing and analysis of the recorded images was more than needed. Today, there is large number of thermal imaging software, which provides simple data acquisition and fast data processing [2].

From the literature, there are number of medical fields in which usage of thermal imaging is well documented and proven (fever screening [3, 4, 5, 6], sport medicine[1], oncology [7, 8], neurology, allergology, nephrology, plastic surgery, dermatology, diabetology, rheumatology, …), but so far no usage in diagnostic of maxillofacial pathology has been reported.

2. EQUIPMENT USED

An infrared camera suitable for evaluating human skin temperature profiles, as suggested in [1] should have the following characteristics:

- High spatial resolution which reflects the separation between two nearby spots. A resolution of 320 (horizontal) $\times$ 240 (vertical) pixels is the minimum requirement.

- High thermal resolution as an expression of sensitivity, defined as the minimum temperature difference that can be measured at two distinct spots.

- Medical CE certification is recommended

- Narrow calibration range accustomed to the human temperature range (i.e., 20–40 °C) assures more detailed temperature readings

- Medical examination software including an export function, for medical analysis report and well-designed software tools for data analysis and image fusion.

In our case, we have used GuideInfrared TP8 infrared camera, [9]. The camera has uncooled microbolometer detector with 384x288 pixels. Spectral range of the used detector is from 8 μm to 14 μm. Thermal sensitivity of the used camera is 0,08 °C at 30 °C. The temperature range is from -20 °C up to 500 °C, with measurement uncertainty of 2 °C or 2 %, whichever is greater. Since we have measured human body temperature, which is in the range of 35 °C to 42 °C, the uncertainty in absolute temperature was 2 °C.

However, we are not interested in absolute value of the temperature, but only in the relative change in comparison to surrounding body temperature. The camera is equipped with appropriate software for data acquisition and post processing data and image analysing tools.

3. MAXILLOFACIAL PATHOLOGY

The maxillofacial pathology represents the specialty that identifies and manages diseases affecting the oral and maxillofacial regions and investigates the causes, processes and effects of these diseases. The practice of maxillofacial pathology includes research, diagnosis of diseases using clinical, radiographic, microscopic, biochemical or other examinations, and management of patients, [10].

4. MEASUREMENTS OF DIFFERENT MAXILLOFACIAL DISEASES

Any change that occurs in the patient's body (inflammation, the appearance of tumours, tissue damage due to mechanical damage,) leads to a partial change in temperature on the surface of the patient's skin. With the thermal imager camera we can detect the exact places where the skin surface temperature deviation occurs and in some way indicates changes which are taking place in the body of the patient, in some depth from the skin. It has to be emphasized that the depth in which change occurred can't be determined only with use of thermal imager. The use of thermal imagers for diagnostic purposes in medicine has been known since the beginning of 2000, as presented in Introduction of this paper. It significantly increased in last couple of years due to falling prices of measuring instruments and the increased prevalence.

In our case, we have made number of different measurements on the patients which have clinically confirmed diseases.

The first patient had sialolithiasis. Sialolithiasis, [11], refers to the formation of stones in the salivary glands. Stones are most commonly found in the submandibular gland, where stones can obstruct Wharton's duct. It is frequently associated with chronic infection (Staphylococcus aureus, Streptococcus viridans) of the glands, dehydration (phenothiazines), Sjögren's syndrome and/or increased local levels of calcium, but in many cases can arise idiopathically. Pain, when present, usually originates from the floor of the mouth, although in many cases the stones cause only intermittent swelling.

Since chewing promotes release of saliva, symptoms tend to increase during meals. A palpable lump or visible swelling in the area of the gland is often noted.

Complications include persistent obstruction of the duct, leading to bacterial invasion, overgrowth and infection (sialoadenitis). This can require IV antibiotics such as nafcillin, and sometimes surgical drainage. The classical diagnosis is usually made by characteristic history and physical examination. Diagnosis can be confirmed by x-ray (80% of salivary gland calculi are visible on x-ray), or by sialogram or ultrasound. On the Figure 1, we can see

thermal image of the patient with sialolithiasis. The difference in temperature on the place of the stone is obvious.
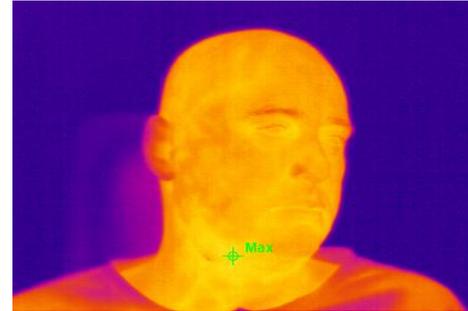

Figure 1: Patient with sialolithiasis

Second patient had the neck cancer. The head and neck cancer refers to a group of biologically similar cancers that start in the upper aerodigestive tract, including the lip, oral cavity (mouth), nasal cavity (inside the nose), paranasal sinuses, pharynx, and larynx. 90% of head and neck cancers are squamous cell carcinomas (SCCHN), originating from the mucosal lining (epithelium) of these regions. Head and neck cancers often spread to the lymph nodes of the neck, and this is often the first (and sometimes only) sign of the disease at the time of diagnosis. Head and neck cancer is strongly associated with certain environmental and lifestyle risk factors, including tobacco smoking, alcohol consumption, UV light, particular chemicals used in certain workplaces, and certain strains of viruses, such as human papillomavirus. These cancers are frequently aggressive in their biologic behaviour; patients with these types of cancer are at a higher risk of developing another cancer in the head and neck area. Head and neck cancer is highly curable if detected early, usually with some form of surgery although chemotherapy and radiation therapy may also play an important role. On the Figure 2, we can see thermal image of the patient with neck cancer. The cancer can be spotted as white areas on the neck in thermogram.
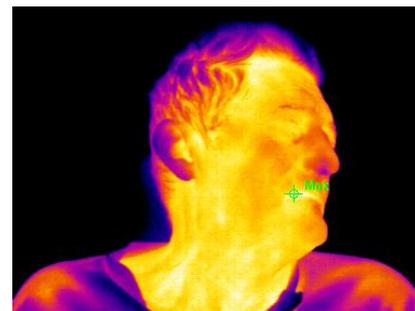

Figure 2: Patient with neck cancer

The third patient had ranula. Mucocele is the most common lesion of the salivary glands, [13]. Mucoceles are the result of trauma. It results from either blockage or rupture of a salivary gland duct, with consequent leakage of saliva into the surrounding connective tissue stroma. Clinically, they present as a fluctuant swelling of the lower lip. It may change in the size during meals. Treatment is complete excision of the cyst.

The term ranula is reserved for mucoceles that arise when the duct of the sublingual gland has been damaged. The sublingual gland secretes continuously in the interdigestive period, whereas the other two major salivary glands only secrete in response to stimuli, such as eating.

A ranula is a type of mucocele found on the floor of the mouth. Ranulas present as a swelling of connective tissue consisting of collected mucin from a ruptured salivary gland duct, which is usually caused by local trauma.

The Latin rana means frog, and a ranula is so named because its appearance is sometimes compared to a frog's underbelly. On the Figure 3, we can see thermal image of the patient with ranula. The temperature on the floor of the mouth on the place of ranula was 0,3 °C higher than the rest of surrounding area.
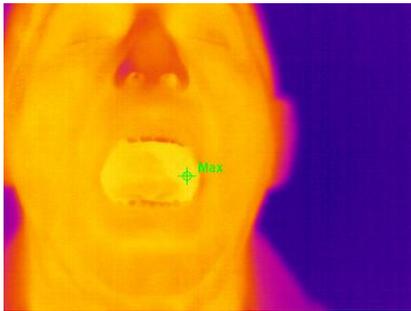

Figure 3: The patient with ranula

Lymphadenopathy is a term meaning "disease of the lymph nodes", [14] It is, however, almost synonymously used with "swollen/enlarged lymph nodes". It could be due to infection, auto-immune disease, or malignancy.

Figure 4: The patient with lymphadenopathy

5. CONCLUSIONS

In this paper we have presented usage of thermal imager in the field of maxillofacial pathology. While thermal imagers are already used in medicine in different fields, its usage in this filed is not documented. It has to be emphasised that first results are very promising. However, further work on different patients and its conditions is needed. Also, it would be very useful to monitor complete pathology from the start of the dieses, until it is fully cured.

At the end, as non-invasive diagnostic technique, this method could be used also for prevention.

In future experiments, we would like to confirm our findings and extent to monitor usage of radiation and reaction to radiation in treatment of tumours in the area of maxillofacial pathology.

6. REFERENCES

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