OMICS Journal of Radiology

Kamburoglu and Yetimoglu, OMICS J Radiol 2014, 3:3
DOI: 10.4172/2167-7964.1000e127

Editorial Open Access

Applications of Terahertz Imaging in Medicine

Kamburoğlu K* **and Yetimoğlu NO**

Department of Dentomaxillofacial Radiology, Faculty of Dentistry, Ankara University, Turkey

***Corresponding author**: Kamburoğlu K, Department of Dentomaxillofacial Radiology, Faculty of Dentistry, Ankara University, Turkey, Tel: 903122965632; E-mail: dtkivo@yahoo.com

Rec date: July 23, 2014, **Acc date:** July 24, 2014, **Pub date:** July 31, 2014

Editorial

Terahertz (THz) electromagnetic waves occupy the spectrum between microwaves and the infrared optical band, which lies within the frequency range of 0.1–10 THz. They represent a large portion of the electromagnetic spectrum and have wide application potentials. THz radiation can penetrate into thin layers of nonmetallic substances like clothing, plastic, and ceramics up to several millimeters. Radiographic imaging using X-rays has been the primary diagnostic imaging technology used within the dental profession since its discovery in 1895. However, it is an ionising radiation with some detrimental effects to our healthand has inherent limitations, such as; superimposition of anatomical structures and poor soft tissue contrast [1]. Unlike X rays, Terahertz waves are non-ionizing and therefore they do not pose a risk to living organisms. Also, they provide images that are comparable to backscatter X-rays. This technology can be used for security screening, semiconductor inspection, food inspection, pharmaceutical inspection, and 2D and 3D imaging, including medical diagnosis in the areas of tooth structure, skin cancer and tumors [1,2].

Both terahertz pulsed spectroscopy (TPS) and terahertz pulsed imaging (TPI) have the ability to explore low-frequency torsional and vibrational motions in molecular systems. These strong vibrations can provide insight into the structural dynamics of polymorphs and hydrates of crystalline materials, which have many applications in pharmaceutical science. The absorption spectrum of water exhibits a very strong, broad peak centred at 5.6 THz. The effect of this absorption peak that extends down to the frequency range used in TPI and TPS makes these techniques highly sensitive to water concentration [3]. THz reflection pulse imaging was used to study human skin in vivo. Authors, investigated freshly excised human tissue, using a broadband THz pulsed imaging system comprising frequencies approximately 0.5–2.5 THz. The refractive index and linear absorption coefficient were found to be different for skin, adipose tissue, striated muscle, vein and nerve [3]. In addition, contrast has been observed between Basal Cell Carcinoma (BCC) and normal tissue in THz images of skin cancer. Authors found that both refractive index and absorption coefficient of BCC was higher than that of the normal tissue [3].

Several samples of excised breast tissue were imaged and parameters from the time-domain pulse were used to assess differences among tissues. The size and shape of tumour regions in the THz images were compared with the corresponding histology section. Authors, found good correlation for the area and shape of tumour compared with that of histology. Als, the the absorption coefficient and refractive index were found to be higher higher for the tissue that contained tumour compared to normal tissue. These studies demonstrated the potential of TPI to image both invasive breast carcinomas and ductal carcinoma *in situ* and encourage further studies [3].

THz imaging was used for oral cancer diagnosis using seven oral tissues from four patients. THz imaging at 20°C showed better contrast between the cancer tissue and normal mucosa than the room temperature. Authors, also detected cancer tumor hidden deeper than 1.2 mm from the tissue surface by observing the temporal domain THz waveform [4].

TPI is also capable of distinguishing between different dental tissues. This gives rise to the interesting possibility of reflecting THz pulses off the dielectric layers in the tooth to gather 3-D information [5,6]. The presence of tooth decay was detected through the changes in the absorption of THz radiation and 3D THz imaging of a tooth was also performed, as the application to clinical practice, so the researchers could measure the thickness of the outer tissue layer. Authors, presented data from a sample of teeth, including a series of 12 human incisors, in which they were able to detect the enamel dentine junction in 91% of the cases. They also imaged artificially altered enamel thickness to within 10 mm of the expected results [5,6]. Kamburoglu et al. [7] analysed a total of 25 teeth samples (9 primary and 16 permanent teeth) and found slight differences between various teeth groups assessed, such as; permanent and primary teeth as well as carious and healthy teeth.

The development of techniques which utilize terahertz waves for applications in medicine is growing rapidly with the development of instrumentation. THz imaging has the potential to be used in assessing several structures. Future studies will focus on increasing the resolution of the sampled area and imaging human structures upon reflection in 3-D.

References

1. Yookyeong CS, Inhee M, Joo-Hiuk S (2009) Frequency-dependent characteristics of terahertz radiation on the enamel and dentin of human tooth. Curr Appl Phys 9: 946-949.
2. Lancaster P, Carmichael F, Britton J, Craddock H, Brettle D, et al. (2013) Surfing the spectrum - what is on the horizon? Br Dent J 215: 401-409.
3. Pickwell E, Wallace V P (2006) Biomedical applications of terahertz technology. J Phys D Appl Phys 39: R301–R310.
4. Sim YC, Park JY, Ahn KM, Park C, Son JH (2013) Terahertz imaging of excised oral cancer at frozen temperature. Biomed Opt Express 4: 1413-1421.
5. Crawley DA, Longbottom C, Cole BE, Ciesla CM, Arnone D, et al. (2003) Terahertz pulse imaging: a pilot study of potential applications in dentistry. Caries Res 37: 352-359.
6. Crawley D, Longbottom C, Wallace VP, Cole B, Arnone D, et al. (2003) Three-dimensional terahertz pulse imaging of dental tissue. J Biomed Opt 8: 303-307.
7. Kamburoğlu K, Yetimoğlu NÖ, Altan H (2014) Characterization of primary and permanent teeth using terahertz spectroscopy. Dentomaxillofac Radiol .