New optical modality for prostate cancer visualization

Besarion Partsvania,[1,*]Tamaz Sulaberidze,[1]Alexandre Khuskivadze,[2] and Ketevan Chubinidze[1]
[1]*Georgian Technical University, Institute of Cybernetics, Tbilisi, 0186, Georgia*
[2]*Tbilisi StateMedical University,Tbilisi, 0160, Georgia*

1. Introduction

Prostate cancer is the second cause of cancer death in men worldwide. The difficulty of imaging methods remains in identifying small volumes of prostate cancer in the prostate gland. Besides, they are partially invasive. The limitations of the imaging methods for prostate cancer detection motivated us to seek of alternative techniques. Here is demonstrated, that near infrared radiation (NIR) can be used successfully for the visualization of cancerous outgrowths in the isolated prostate.

2. Methods

Prostate glands were obtained from the radical prostatectomy. Light emitted diode (LED) was utilized for prostate transillumination. Emitting wavelength was 850 nm. To observe the prostate glands in the NIR spectrum a 15 megapixel resolution CCD camera, coupled to a personal computer was used.

In figure 1 (a) by the arrows 1, 2, 3 and 4 are shown LED, CCD camera, power supply and computer, respectively. In the figure 1b is shown prostate placed on Petri dish between CCD camera and LED. Infrared light pass through prostate and is captured by CCD camera. CCD camera is connected with PC and we receive prostate infrared image. System is placed in darkness to avoid artifacts of visible light.

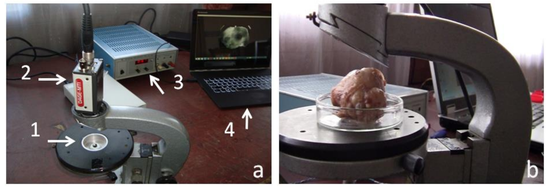


Figure 1.

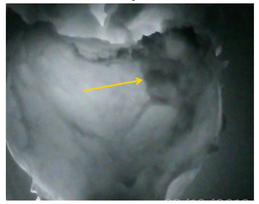
Isolated prostate was firstly investigated in NIR and locations of cancerous outgrowths were determined. Furthermore, the prostate glands were examined histo-morphologically, based on the standard methods, which enable a tumor to be located precisely in the prostate tissue . Accordingly, a location of each cancerous outgrowth was determined using two methods: one which was detected by histo-morphological examination and other, by means of the NIR investigations. Because the investigations were carried out on the base of a standard method, we did not consider including here an illustrative stuff of the histo-morphological examinations.

3.Results

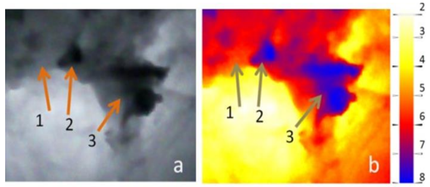
Infrared image of the non-cancerous prostate is characterized with brightness homogeneity. Figure2 A- view from the rectum side. (Arrow indicates edge of Petry dish). Infrared image of the cancerous prostate is characterized with extremely non homogeneity. Tis is so because cancerous tissue optical density is much higher than density of noncncerous tissue. In the figure 2B is shown one of the cancerous prostates IR image. View from the rectum side. The dark area located in the upper right part of the picture (shown by arrow) corresponds to the cancerous outgrowth. After the NIR investigation, this prostate gland was examined hysto-morphologically. In this case Gleason score was 7.

We have developed a software. It enables to map out the distribution of prostate cancer with different aggressiveness in the color expression- Figure 2C. Here is demonstrated a part of the prostate gland in grayscale (a), and in color (b) representation. As shown in the grayscale picture, the cancerous outgrowth with highest aggressiveness are the darkest areas indicated by the arrows 2 and 3. Less aggressiveness corresponds to the area indicated by the arrow 1. On the colored part of the picture, the cancer with highest aggressiveness are shown in blue (arrows 2 and 3), while with the less aggressiveness are shown in red (arrow 1). Right hand side of the picture represents the color bar.

A)



B)



C)

Figure2.

On the basis of our investigations we have developed and fabricated prototype of future device for prostate cancer diagnosis *in vivo*. Device consists from IR illuminator-figure 3a, which will be placed in the prostate through urethral channel and from the IR detector –figure 3b, which will be placed in the rectum. Detector is connected to PC. Elaborated software forms prostate infrared images and determines existence of cancer with 95% probability.

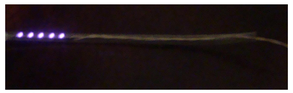


Figure 3a

Figure 3b