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Miming of Prostate Cancer Diagnostics

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Introduction

Prostate cancer is the second leading cause of cancer-related death in males globally, Prostate cancer often does not show any symptoms unless it is quite advanced, and treatment or surgery is very ineffective in the later stages. A key factor in identifying prostate cancer at an early stage is screening, which is based on the detection of PSA in the blood. However, PSA lacks selectivity and may even rise in the presence of other prostate diseases. The instrumental methods of prostate cancer detection have some shortcomings: DRE is highly subjective. MRI method include lower specificity, the potential for false positivity and high costs. TRUS should not be used as a first-line screening study as it lacks acceptable specificity. The shortcomings of imaging methods for detecting prostate cancer have led to the search for alternative techniques, such as the infrared (IR) imaging method.

Methods and materials

Experiments were conducted on prostates obtained after radical prostatectomy (32 prostates). We have developed an IR light tool for illuminating the prostate from within, shown in Figure 1. The tool is a flexible strip that will be placed in a catheter. Light emitted diodes (850-900 nm) were mounted on the strip.

Figure 1. Prostate illumination tool.

The strip can be turned on 360 degrees in the catheter and illuminate any desirable zone of the prostate. To obtain IR images of the prostate we created and assembled an original device. The device sown in the Figure 2 consists of a CCD camera sensitive to the IR light. The device is equipped with lens systems and allows observation of whole prostate.

Figure 3. The device

Results and Discussion

The isolated prostate and its IR image are shown in figure 3. Left-isolated prostate; right-IR image. The illumination of areas corresponding to cancerous tissue (sown with an arrow) is significantly lower than that of areas identified as noncancerous tissue. Consequently, areas corresponding to malignant tissue appear much darker on the IR image compared to areas corresponding to noncancerous tissue.

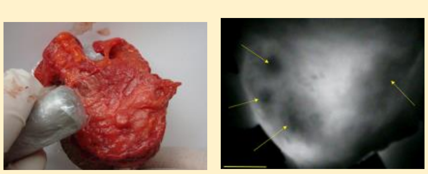

Figure3. Isolated prostate and device-left; IR image –right. Malignant areas are shown with arrows.

We developed the software that produces and analyzes the IR image. The essence of the program is that it compares the illumination intensities of areas corresponding to malignant tissue to the illumination intensities of areas corresponding to noncancerous tissue on the IR image and calculates their ratio. Based on the calculated meaning of this ratio, it determines the malignancy of the prostate tissue with a probability of 95%.

The calculations indicate that this interval was between 0.46 - 0.57. Thus, the intensity of illumination of cancerous tissue is approximately half that of noncancerous tissue. This is due to the higher optical density of cancerous tissue compared to noncancerous tissue. We can use the program to examine any new, unidentified prostate. The software will follow the procedures outlined above for this unidentified prostate. It will compute the aforementioned ratio and determine if it falls within the computed range of 0.46 -0.57. If it does, we can conclude that this prostate is malignant with a 95% probability.

After infrared examination, the prostate was always investigated by the well-known standard histo-morphological method. This study, in all cases, revealed areas of cancer in the prostate gland and precisely indicated their locations. As a result, we were aware of the existence of the tumor sites determined by histo-morphological analyses as well as the areas determined to be malignant based on IR imaging.

We regard the provided experiments as model experiments. The purpose of conducting model experiments is to simulate real-life scenarios using an isolated prostate.

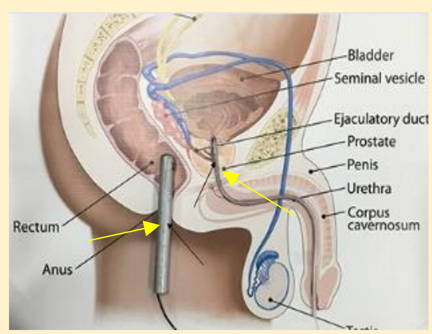

Figure 4. Modeling of experiment

A model of infrared (IR) imaging of the prostate is presented in the figure 4. It shows the prostate and other male organs. Arrows indicate the device used to obtain the prostate IR image and the IR illumination strip. The dimensions correspond to an average-sized man. This figure represents a scenario where the device will be inserted into the rectum and a catheter with a lighting strip inside the urethral channel will be used to illuminate the prostate internally. In order to create this figure, we first took a schematic picture of a man's prostate and other organs, placed developed gadget on it, and then took picture.

Conclusion

Model experiments have demonstrated that our device is effective in detecting and visualizing prostate tumors. Although the device used in the experiments is a prototype, it can be readily used for human patients. The clear benefit of the NIR method is its ability to detect small cancerous areas.