The re-design of the DRS probe for breast conserving surgery.

Public summary

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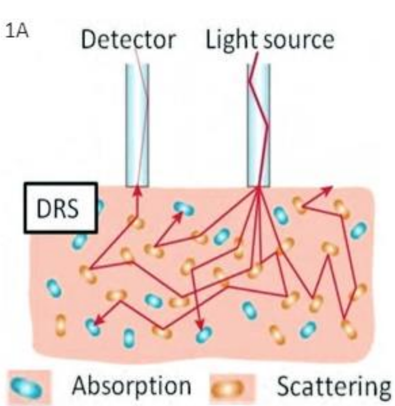
Subject

The Netherlands Cancer Institute (the NKI) conducts research into cancer treatment for many years. One of the studies is the development of smart surgical instruments. The diffuse reflectance spectroscopy (DRS) probe is one of the smart surgical instruments and is used for breast cancer surgeries. A current prototype is in use but is perceived as not ideal. A redesign for this instrument is the subject of the thesis.

Background

Breast cancer is a global disease that is diagnosed only in the Netherlands by about 15.000 women every year. [1] One of the preferred treatments is breast-conserving surgery (BCS). BCS is a local treatment to remove only the malignant tissue and attempt to leave as much of the breast intact as possible. To be sure that all cancer tissue has been removed from the patient an extra margin of tissue around the malignant tissue will be taken away. Which will be tested after or during surgery.

Because no distinction can be made between healthy and malignant tissue during surgery, the surgeon cannot operate as precisely as he or she would like. Therefore, the chance of remaining malignant tissue is present. To prevent this and to improve the treatment method, a technology that will help with the detection of the borders of tumours has been developed. Diffuse reflectance spectroscopy, DRS, is a technology that can distinguish malignant tissue from healthy tissue by means of optical measurements.



DRS is a technique based on optical fibres placed in a probe used to transfer light from a light source to the tissue. In the tissue, the light will be absorbed and reflected. A detecting optical fibre will capture this reflected light. This captured light is converted in a spectrometer into DRS spectra. From these spectra, a distinction can be made between the tissues.

During the operation, the instrument will be used to measure different areas around the tumour. A tumour can be located anywhere in the breast and can vary from a palpable to a scattered tumour. The probe should approach the tumour from all sides.

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FIGURE 1: DRS TECHNOLOGY [2]

Definition of the problem

First conclusions on the use of the current used DRS probe, (see figure 2), are that the probe is too thick and limits the freedom of movement during surgery. Because of the thickness of the probe, different locations of the tumour and the way you can approach them is limited. This results in the demand for a better design for this instrument.

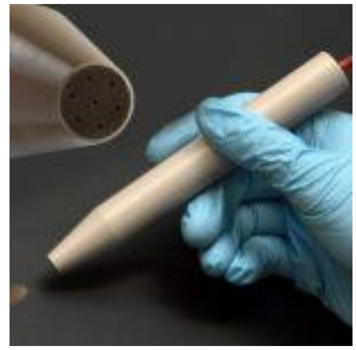

FIGURE 2: THE CURRENT USED DRS PROBE [3]

And the main research question is the following: *Which redesign would improve the current probe?*

The goal of the research was to develop a probe that can be used for better reachability of all the locations and edges of the tumour.

Methods

Several methods are used to approach the best possible design and to create a new concept.

In the first phase, a list of requirements is gathered. A preliminary study with different methods has been carried out for this purpose. Initially, desktop research was carried out in which the current state of the art was determined. Interviews with stakeholders such as surgeons, experts and the sterilization department determined the basic requirements for the instrument. These demands were combined with the current state of the art. Field research into the execution of operations and its requirements was necessary to investigate the practical aspects of the design.

After the first phase, the first concepts could be developed. These concepts were influenced by several design elements. These elements were approached and analysed separately and produced in test parts. These test parts were discussed with the surgeons and experts to come to the best possibilities for the concept. The results of the tests were converted into a final product concept.

Lastly, research into the best manufacturing methods were carried out to give recommendations for a proper development method of the design. Resulting in a suggested manufacturing design.

Results

The result is a thinner DRS probe with a radius in the design. Using a thinner design and angle in the design will result in a better approach of the different tumours and its sides during surgery.

Conclusion and recommendations

Because the final product concept has not been tested yet, it will have to be tested with the surgeons during a real-life experience. A further investigation of the best production method is recommended.

References:

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[2] D. J. Evers, Optical sensing for tissue differentiation, Enschede: Twente University, 2014.

[3] "PhD student optische weefselherkenning voor oncologische chirurgie," Netherlands Cancer Institute, 9 August 2019. [Online]. Available: https://igs.nki.nl/index.php/2019/08/09/phd-student-optische-weefselherkenning-voor-oncologische-chirurgie/. [Accessed 31 July 2020].