

Document:

Clinical Need

Project:

Ultrasound Needle Guidance for Hydrogel Injection During Cervical Cancer Brachytherapy

Name:

Tracy Kao

Date of Last Revision:

4/17/2018

Cervical cancer is the third most common cancer among women worldwide, with an annual incidence of 530,000 cases and 250,000 deaths yearly. Unlike early-stage disease, locally advanced cervical cancer has finite survival times and cannot be cured by surgery alone (with a high relapse rate at 30%). In 2018 alone, there are 13,240 projected new cases of cervical cancer. Also in this same year, 4,170 deaths from cervical cancer are estimated to occur.



Delivery of brachytherapy using applicators placed in the cervix

In the developing world, it is even the second leading cause of cancer. Recent data have repeatedly and consistently shown the benefit of administering brachytherapy, the insertion of a radiation source directly into the cancerous tissue, following external beam radiotherapy (EBRT) to prolong survival and to improve patient outcomes (when coupled with chemotherapy). There is a clear need to

differentiate the cervical tumor mass from surrounding normal tissues e.g. the rectovaginal septum during brachytherapy.

In brachytherapy planning, it is routine practice to inject a hydrogel spacer to minimize radiation dose to normal anatomical structures. However, brachytherapy is a challenging procedure, which requires accurate, real-time tracking and contouring of the cervical tumor mass to achieve maximal tumor control while maintaining minimal radiation toxicity to surrounding nearby structures e.g. the bladder and rectum. Inaccurate needle placement can lead to complications such as accidental perforation of the bowel and rectum. The width of the tissue between the vagina and the rectum is only 0.5 cm thick, and under limited visual conditions, can be difficult to access and maneuver. In this project, we want to develop a method for more precise localization and/or visualization of the needle for hydrogel injection under ultrasound image guidance during preparation of the cervical cancer patient for a brachytherapy procedure.

While other imaging technologies have been investigated (e.g. intraoperative MRI and preoperative MRI/CT), they are limited in terms of practicality and cost. This is especially a challenge in resource-limited countries which often harbor the highest rates of locally advanced disease (in part due to limited screening and unavailability of vaccines).

In response to this clinical need, our project comprises two main objectives: 1. The development of an adapted hydrogel spacer injection needle with an active ultrasound element mounted on it in order to provide real-time feedback of its position to an accompanying ultrasound probe set for detection, and 2. The construction of a phantom that is durable and reusable that can be used to train residents and other medical professionals on the hydrogel injection procedure. We **hypothesize** that this needle-sized ultrasound imaging system and training phantom can be used for reliable and accurate guidance of needle placement into the recto-vaginal septum for hydrogel injections during brachytherapy.

For further reading regarding cervical cancer incidence and statistics, please refer to the following website:

<https://seer.cancer.gov/statfacts/html/cervix.html>

For further reading regarding brachytherapy, please refer to the following paper:

Banerjee, Robyn, and Mitchell Kamrava. "Brachytherapy in the treatment of cervical cancer: a review." *International journal of women's health* 6 (2014): 555.

For further reading regarding hydrogel spacing in brachytherapy procedures, please refer to these papers:

Damato, Antonio L., Megan Kassick, and Akila N. Viswanathan. "Rectum and bladder spacing in cervical cancer brachytherapy using a novel injectable hydrogel compound." *Brachytherapy* 16.5 (2017): 949-955.

Viswanathan, Akila N., Antonio L. Damato, and Paul L. Nguyen. "Novel use of a hydrogel spacer permits reirradiation in otherwise incurable recurrent gynecologic cancers." *Journal of clinical oncology* 31.34 (2013): e446.

