Advances in Image-guided Brachytherapy

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Introduction

What is Brachytherapy?
How we do it in a traditional way?
What is Brachytherapy

- Radiative source ➔ radiation ➔ destroy cells
- Brachy: short distance ➔ Close to target ➔ receive much more radiation

Radiative source

Target
e.g. cancer cells
Standard treatment for **Cervix Cancer**

- Standard treatment for gynecological disease, especially cervix cancer
- Put an **applicator** into patient’s body through natural cavity
Standard treatment for Cervix Cancer

• Load **radiative source** into applicator (i.e. a path for radiative source)

• Giving **radiation dose** to the target (cancer cells)
Commonly used method:
Manchester point A system

* Define a point A
* Prescribe dose to point A
* Create a **pear shape high dose volume**
* Suppose the target is within this high dose volume

ABS guidelines 2000
Problems of traditional 2D planning?

Why we need Image-guided Brachytherapy (IGBT)?
Lack of information

* From a 2D X-ray image, no contrast of soft tissue
* **Uncertain the geometry** of both target/normal tissue
Because we cannot see the target unique radiation dosage

- Same dose for all patient, whatever size/shape of tumor
- Maybe **underdose** for more advanced stages/bulky tumors
Defined **point dose for normal tissue dose** may not be representative.

- The dose at these points **may not correlate to the normal tissue complications very well**

Bladder & rectal dose reference

ICRU 38

- Bladder: Point at the posterior surface from the centre of a 7cc Foley balloon set on the bladder trigone.
- Rectum: Point at 5mm behind the posterior vaginal wall (5mm behind the posterior surface of ovoids).

International protocol
Can you detect improper applicator placement e.g. uterine perforation?

From 2D?

From 3D?
Image-guided Brachytherapy (IGBT)

3D Volumetric images

Moving from 2D planning to 3D planning

Let us solve the problems!
Computed Tomography (CT)
Magnetic Resonance Imaging (MRI)
Gold Standard
With **volumetric images**, you can

* See and outline the target and normal tissue
* **Verify applicator position**, detect uterine perforations
* **Optimize the dose**: more dose to target and less dose to normal tissue
* **Adaptive treatment**
GEC ESTRO recommendations and new ICRU guidelines

**Target**
- Dose to point A
- Dose to volumes

**Normal tissue**
- Dose to ICRU points
- Dose to volumes

GEC ESTRO I | Haie-Meder 2005
---|---
GEC ESTRO II | Potter 2006
Interstitial Needles

new path for radiation source

Without needle

With needle
Larger high dose volume to cover target
Dose optimization
more dose to target and less dose to normal tissue

Standard plan

Optimized plan
Adaptive planning
re-contour the normal tissue each fraction

Different shape of normal tissue at different time e.g. Bladder volume
Pre-treatment virtual planning

- Predict the dose of real treatment
- Optimize treatment e.g. determine needle position and length
- Help decision making
Favorable outcome of IGBT overseas experience

Improved survival

Reduced toxicity
IGBT experience in PYNEH

* IGBT for cervical cancers since **January 2015**
* **1st MRI based planning** in Hong Kong
* MRI/CT based planning for all cases
* **1st interstitial needle case** in Hong Kong in September 2015
* Pre-treatment virtual planning to optimize the treatment
Role of Physicists in IGBT Commissioning & Quality Assurance

make sure the intended dose is delivered accurately to the intended location

Commissioning of MR compatible applicator

Confirmation of needle position

Independent dose calculation

Confirmation of needle length
Role of Physicists in IGBT Treatment Planning

stimulate the dose in patient for the treatment

Image registration

Dose Optimization

Applicator reconstruction
Role of Physicists in IGBT
Research and Education

Effectiveness of week 5 MRI virtual preplanning for Image-Guided Brachytherapy for cervical cancers

HRCTV - Dose Relationship (no needles inserted)

Target size vs dose coverage

IGBT workshop 2015 at PYNEH
IGBT: the movement from 2D planning to 3D planning (CT/MRI)

IGBT has the potential that makes brachytherapy more accurate, safe and effective

IGBT has been implemented in PYNEH last year
Team work
Collaboration among different disciplines

- Oncologists
- Gynecologists
- Radiologists
- Anesthesiologists
- Nurses
- Radiation therapists
- Physicists
Our IGBT team

Thank You!