Adjuvant Radiotherapy in a Pregnant Patient with Squamous Cell Carcinoma (SCC) of the Tongue: Importance of Fetal Dose Minimization

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Background

- A pregnant female in her early 30s with a history of smoking was diagnosed with a multifocal tongue tumor in the first trimester of pregnancy.
- She underwent surgical tongue resection with right and left partial glossectomy and bilateral level 1-4 selective neck dissection.
- Postoperative pathology revealed two separate foci of squamous cell carcinoma involving the right and left tongue.
- Given depth of tumor invasion, close margins, and evidence of lymphovascular invasion, she was deemed:
  1) to be at high-risk for disease recurrence and
  2) to be suitable for postoperative radiotherapy
  - Her risk of recurrence was estimated to be at least 25% and potentially as high as 40-50%, and her risk of death within 3 years 20-25% without additional treatment.
- Prior literature established the following effects of radiation dose exposure to the fetus:
  - Developmental effects are dependent upon dose, stage of gestation, and dose rate.
  - 2nd trimester: fetal exposure particularly may result in fetal: microcephaly, growth restriction, cancer later in life, neurocognitive, neuroendocrine, and neuropsychological disorders.
  - Fetal growth effects are more evident at fetal doses above 10 cGy, but any dose will increase the baby's lifelong cancer risk.

Hypothesis

- For a pregnant patient requiring adjuvant radiotherapy to the head and neck, planning and shielding techniques could reduce fetal dose to published acceptable levels.

Methodology

- In this project, we demonstrated techniques to reduce fetal dose to as low as reasonably achievable.
- Informed patient about the risks, benefits, alternatives, procedures, personnel involved, and possible acute and late side effects.
- Conducted a review of the literature.
- Developed a radiation plan: 60 Gy in 30 fractions to the tongue and neck with 6 mega-voltage (MV) photon beams.
- Radiation to the fetus occurs from head leakage (direct scatter) and radiation being defected downwards within the body (indirect scatter).
  - Direct scatter was reduced with cerrobend shielding pictured below.
  - Indirect scatter was low given the distance between the neck (treated area) and the fetus.

Fig. 1.

- Cerrobend, a low-melting alloy ideal for molding and photon modifying, was placed around the abdominal region with 1.5 cm as the optimal half-value layer for 6 MV.
- Doses to the umbilicus and 8 cm superior to umbilicus were measured using a thermoluminescent dosimeter (TLD) on an anthropomorphic phantom.
  - We subsequently compared patient TLD doses with the phantom.

- Planning techniques:
  - We rotated the collimator so that the jaw was positioned to maximally block head leakage in the fetal direction while still allowing target coverage.
  - We further reduced radiation head leakage by applying constraints to minimize the monitoring units required.
  - We used partial arcs to avoid the 40° posterior to the patient where custom shielding was limited.
- We targeted a maximum fetal dose to be below 10 cGy.

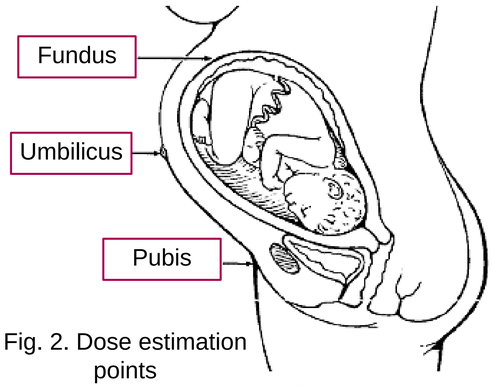

Fig. 2. Dose estimation points

Stovall et al: Fetal dose from radiotherapy with photon beams

Results

Phantom Measurements

Shielding	Location	30 FX Dose (cGy)	Shielding Reduction (%)
UNSHIELDED	8CM	12.7	
UNSHIELDED	UMBILICUS	6.8	
SHIELDED	**8CM**	**10.9**	**14%**
SHIELDED	**UMBILICUS**	**3.4**	**50%**

Patient Measurements

Shielding	Location	30 FX Dose (cGy)
SHIELDED	**8 CM Superior of Umbilicus**	**6.52**
SHIELDED	**Umbilicus**	**3.33**
SHIELDED	**Pubis**	**1.48**

Conclusions

- Fetal protection is vital during radiotherapy because although the patient's risk of disease recurrence is reduced, the fetus is susceptible to the adverse long term effects of radiation exposure.
- Radiation exposure to the fetus can be reduced by a number of techniques, including:
  - Blocking techniques, such as cerrobend shielding around the patient's abdomen and pelvis
  - Avoiding radiation beams entering where shielding is limited
  - Planning techniques to minimize head leakage, such as optimizing the collimator angle and minimizing monitor units required.
  - Clinicians need to consider all of these factors as well as use humanistic approaches in order to formulate an optimal treatment plan.

Recommendations

- Radiotherapy during pregnancy should not be carried out as a standard treatment.
  - Meticulous planning and appropriate treatment modifications are required (e.g. changing field sizes and angles, estimating doses with and without shielding, constructing a custom shield, staying within any safety limits, and documenting fetal doses during the procedures).