Evaluation of Simultaneously Integrated Boost (SIB) and Sequential IMRT Boost (SqIB) Treatments of Head and Neck Cancer using Empirical Radiobiological Modeling

American Association of Physicists in Medicine Annual Meeting
(Aug 03-08, 2013; Indianapolis Convention Center, Indianapolis, IN)

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Objective

• To evaluate and compare normal tissue complication probabilities (NTCP) in SIB (simultaneous integrated boost) and SqIB (sequential IMRT boost) methods of IMRT in head and neck cancer using the radiobiological modeling of HART* program

Methods

• IRB approved study
• 40 H&N IMRT cases treated with SIB (Rx: 66–70 Gy)
• 14 were studied
  • 11 had dysphagia at 2 year follow-up
  • 10 had xerostomia at 2 year follow-up
  • 9 had both dysphagia & xerostomia at 2 year follow-up

• 10 SqIB were also studied (Rx = 73.5 Gy)
TCP and NTCP

- TCP is derived from DVH of tumor using Poisson statistics.
- NTCP is derived from DVH of the normal tissue using JT Lyman model.
- Values for the volume parameter (n), slope parameter (m), tumor control dose (TCD=63.8Gy) and tolerance dose (TD_{50,5} = 46 and 47 Gy for bilateral parotids and esophagus, respectively) were selected from Luxton et al. (*Phys. Med. Biol.* 53, 23-36, 2008).
Results

• For N=14 SIB patients:
  • TCP of tumor = 0.78±0.02
  • NTCP for parotids = 0.16±0.10, and
  • NTCP for esophagus = 0.20±0.06

• For N=10 SqIB patients:
  • TCP of tumor = 0.83±0.02
  • NTCP for parotids = 0.45±0.14, and
  • NTCP for esophagus = 0.17±0.09
Results – 1

Dysphagia

\[ y = 0.1253x \]
\[ R^2 = 0.604 \]
Results – 2

![Graph showing the relationship between NTCP (Parotids) and Severity with the equation $y = 0.1602x$ and $R^2 = 0.0898$.](image-url)
Conclusions – 1

• In a 2-year follow up study with SIB treatments, the estimated values of NTCP of esophagus correlated with the severity of dysphagia.
• JT Lyman model provided good correlation between severity of xerostomia and NTCP of parotids; and PS models for tumor progression free survivability in SqIB treatments.
• The hot spots were also reduced and better parotid sparing was found in SIB method than in SqIB method which may partially be related to smaller prescription doses.
Conclusions – 2

• These findings are not in direct comparison due to the differences in Rx dose, tumors and stages.
• This novel methodology of radiobiological outcome-related analysis may be utilized to evaluate different treatment plan techniques.