radiation-induced acoustic waves. Acoustic signals were detected at 60 positions around the radiation field by rotating the collimator and an XACT image was reconstructed using a simple back-projection algorithm. Based on XACT theory, XACT images in a homogeneous water tank are relative dose images. Film measurements were made using a standard EBT3 film protocol and compared to XACT images using gamma analysis.

Results

Fig. 1 and Fig. 2 show the XACT and film images, respectively, of the dose delivered at a single control point during the VMAT delivery. When comparing the XACT and film measured dose distributions, 74.8% of points receiving at least 10% of the maximum delivered dose pass a 3%/3mm gamma test. The largest discrepancies between XACT and film dose distributions occur in the center of the field, which can be attributed to the limited bandwidth of the transducer. XACT agrees well with the film measured dose distribution in regions of high dose gradient, with 98.7% of points receiving between 20% and 80% of the maximum dose passing a 3%/3mm gamma test. XACT and film images of the cumulative dose distribution delivered by an arc spanning six degrees and consisting of four control points were also obtained. 96.6% of points in high dose gradient regions passed a 3%/3mm gamma test.

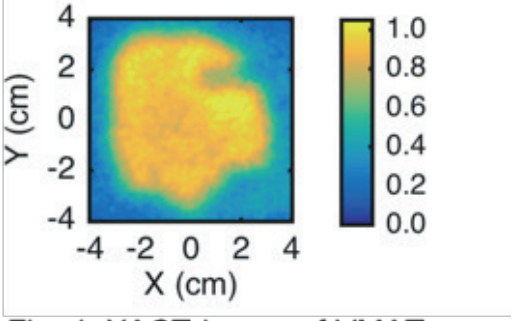

Fig. 1: XACT image of VMAT field

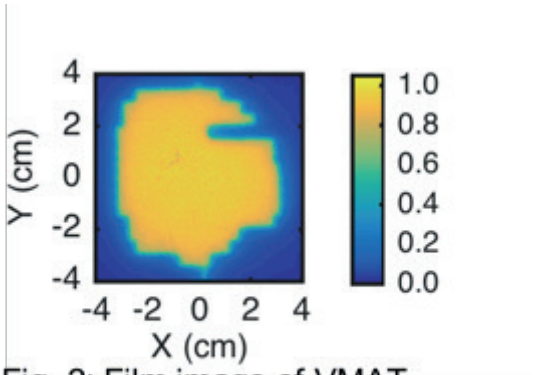

Fig. 2: Film image of VMAT field

Conclusion

This work shows that XACT has the potential to be a powerful dosimetry technique for measuring the dose delivered by non-standard beams, such as those used in VMAT treatments. Since XACT generates images from a single pulse of irradiation, it could be used to troubleshoot exactly which portions of beam delivery fail. XACT takes advantage of intrinsically produced acoustic waves, does not perturb the radiation beam, and is energy and dose-rate independent. Additionally, XACT is inherently 3D due to the spherical nature of acoustic wave propagation. Thus, using a 3D transducer array could allow XACT to be expanded to a 3D dose measurement technique, which would be an invaluable tool for verifying the delivery of complicated dose distributions.

Proffered Papers: PH 12: Audits and QA

OC-0608 Radiotherapy quality assurance program for the STAR-TReC trial; planning results of Dutch centers

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Purpose or Objective

The STAR-TReC study is a multi-center, randomized, phase II study comprising a randomization between; a) Total mesorectal excision (TME), b) organ preservation utilizing chemoradiation (CRT) and c) organ preservation utilizing short course radiotherapy (SCRT) (ClinicalTrials.gov Identifier: NCT02945566). Mesorectal radiation without elective lymph node areas is used. Because this is a novel technique, a radiotherapy quality assurance (RTTQA) program has been setup. Pre-trial QA consists of a benchmark contouring and a benchmark planning case. The aim of this study was to report on the planning results of Dutch participating centers.

Material and Methods

The CTV on the pre-contoured CT scan included the mesorectum from the S2-3 interspace up to 2 cm below the tumor (with a maximum of 1 cm anal canal). The CTV-PTV margin used is 1.5 cm ventrally and 1 cm in all other directions. Centers were asked to plan in accordance with the STAR-TReC planning guidelines. 3D conformal radiotherapy (3D-CRT) or intensity modulated radiotherapy (IMRT/dynamic arc) were allowed. Plans for both SCRT (5x5 Gy) and CRT (25x2 Gy) were produced for the benchmark case. PTV constraints were >99% for V95, 100% for V90, <1% for V105 and D 1.8cc needed to be <107%. There is no consensus concerning dose volume constraints for the organs at risk (OAR). As such, there are no mandated OAR dose constraints, but optimization goals were suggested based on a pre-trial planning study in 20 patients (Appelt et al., Radiother and Oncol, Vol. 123, S962–S963). OAR included bowel cavity according to RTOG guidelines with extraction of the CTV, bladder and femoral heads. Central evaluation of treatment plans was performed.

Results

Eight Dutch centers completed the RTTQA using different planning techniques: dynamic arc (n=6), IMRT (n=1) and 3D-CRT (n=1). Different treatment planning systems (TPS) were used: Pinnacle (n=4), Eclipse (n=2), Monaco (n=1) and RayStation (n=1). The number of arcs/fields varied

from 1-4 for dynamic arc. All plannings fulfilled the PTV constraints. Table 1 summarizes the DVH results for the SCRT and CRT plans for all centers. There was a wide variation between centers. Even centers using the same technique (dynamic arc) and TPS (Pinnacle) showed large variation in low dose bowel cavity volumes (table 1, last column). This variation is due to a different choice in trade-off between dose to the bowel cavity and the femoral heads in some centers, but other centers managed to achieve low dosages to all defined OARs.

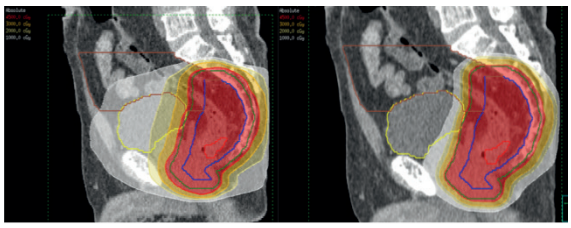

Figure 1
Example of two different dose distributions of CRT plans by centers using dynamic arc and Pinnacle

TABLE 1. Treatment planning results for the SCRT and CRT plans of all centers and for the CRT plans of centers using dynamic arc and Pinnacle.

		SCRT; all centers (n=8)		CRT; all centers (n=8)		CRT; centers using dynamic arc and Pinnacle (n=3)	
Parameter SCRT/CRT	Goal SCRT/CRT	Average (SD)	Range	Average (SD)	Range	Average (SD)	Range
Bowel cavity V10Gy/V20Gy (cc)	<200 / <190	122.6 (28.9)	88.4-164.6	126.0 (31.1)	89.1-164.4	108.6 (29.6)	90.0-142.8
Bowel cavity V18Gy/V30Gy (cc)	<120 / <130	71.2 (10.1)	59.6-90.5	86.7 (14.9)	69.9-113.1	79.1 (11.6)	70.1-92.3
Bowel cavity V23Gy/V45Gy (cc)	<90 / <100	51.3 (7.7)	43.6-67.8	54.6 (7.8)	46.3-71.1	51.2 (4.6)	46.3-55.4
Bladder V21Gy/V35Gy (%)	<15 / <22	0.7 (0.9)	0.0-2.8	2.8 (2.0)	0.4-5.6	2.0 (2.0)	0.7-4.3
Bladder V25Gy/V50Gy (%)	<7 / <7	0.0 (0.0)	0.0-0.0	0.0 (0.0)	0.0-0.0	0.0 (0.0)	0.0-0.0
FemoralHead_L V12.5Gy/V25Gy (%)	<16 / <14	3.9 (6.1)	0.0-17.4	2.8 (3.9)	0.0-11.1	5.6 (5.1)	1.0-11.1
FemoralHead_R V12.5Gy/V25Gy (%)	<16 / <14	2.4 (4.0)	0.0-9.8	2.9 (4.7)	0.0-11.3	6.8 (5.0)	1.4-11.3

Conclusion

This study demonstrates large variability in OAR DVH results for a novel technique despite planning guidelines and underlines the importance of RTTQA in clinical trials. This variability demonstrates the differences in choices made in OAR sparing that exists between centers in daily practice. Results of the planned consensus meeting to further optimize the technique and achieve best practice will be presented.

OC-0609 Patient specific plan QA for clinical trial EORTC 1219 using Knowledge-Based Planning

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Purpose or Objective

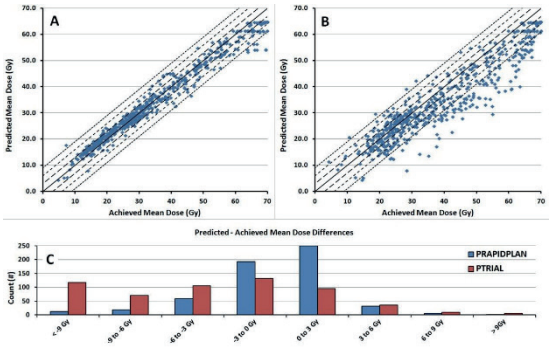
Radiotherapy treatment plans of patients enrolled in clinical trials are commonly subject to generic quality-assurance (QA) testing to ensure that various protocol aims for organ-at-risk (OAR) sparing and planning target volume (PTV) dose coverage are met. However, such generic QA does not indicate whether the submitted plan is close to optimal for an individual patient. We used a commercial knowledge based planning solution capable of predicting achievable OAR doses for individual patients to retrospectively perform patient-specific QA of 100 locally advanced head and neck cancer (LA-HNC) treatment plans accepted into the EORTC1219-DAHANCA29 intergroup study.

Material and Methods

A RapidPlan (Varian Medical Systems) model was generated, based on a library of 177 patients with LA-HNC previously treated at our center, and not included in the trial. For a new patient this model generates a dose-volume prediction range per OAR from which we calculated the predicted mean dose. It can also generate patient-specific optimization objectives for the OAR. In the Eclipse treatment planning system, a script was written for automated setup of 2 VMAT arcs and automated call-up of RapidPlan followed by RapidArc optimization. This was performed using the delineated CT-scans of the first 100 patients of the study. We compared the mean dose to the parotid glands (PG), submandibular glands (SMG), individual swallowing muscles (SM) and oral cavity of the trial plans to the mean doses predicted by RapidPlan and the doses achieved in actual RapidPlan plans.

Results

Time to automatically setup a new treatment plan and generate OAR DVH predictions was <2 minutes; full personalized plan generation was <30 minutes per patient. Averaged over all patients, mean doses for plans made by RapidPlan were 2Gy, 9Gy and 3.8Gy lower than those in the trial plans for PG, SMG and composite SM, respectively. Figure 1 shows the comparison of RapidPlan predicted mean dose with RapidPlan achieved mean doses (A) and trial plans (B) for all 570 individual OARs. 195 individual OARs in the trial plans could be improved by >5Gy, whereas 22 were >5Gy lower than predicted by RapidPlan. 78% of the RapidPlan and 43% of the trial plans achieved mean OAR doses within 3 Gy of the predicted mean doses (A). Since lowering dose to one OAR might result in increased dose in another OAR, we also compared the average of the mean doses to salivary glands, SM and oral cavity. Of the trial plans, 30, 14 and 5 had average mean doses 3-6Gy, 6-9Gy and >9Gy higher than plans made by RapidPlan.



Conclusion

Despite generic plan QA of plans in a clinical trial, there was a large variation in plan quality. Patient-specific QA benchmarking plans against predicted OAR doses can be performed within a matter of minutes, using scripting and a good RapidPlan model. In practice the results of the prediction could be used to provide feedback to the participating trial centers and stimulate improvements in plan quality.

OC-0610 A multi-national inter-comparison clinical trial IMRT QA exercise

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Purpose or Objective

Clinical trials are increasingly international; therefore, the quality assurance (QA) which is carried out in each country needs to be comparable. The Clinical Trial QA Global Harmonization Group's (GHG) main objective is to