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Short interactive workshops reduce variability in contouring treatment volumes for spine stereotactic body radiation therapy: Experience with the ESTRO FALCON programme and EduCase™ training tool

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ABSTRACT

We report the results of 4, 2-h contouring workshops on target volume definition for spinal stereotactic radiotherapy. They combined traditional teaching methods with a web-based contouring/contour-analysis platform and led to a significant reduction in delineation variability. Short, interactive workshops can reduce interobserver variability in spine SBRT target volume delineation.

Contouring target volumes and organs at risk (OARs) is a key step in the radiation oncology treatment process, and the requirements for delineation are continuously evolving due to technical and clinical advances [1–6]. Although contouring guidelines and atlases are available for many scenarios [7–14] high, clinically relevant, inter- and intra-observer variability still remains an important issue [15–21] and differences between available guidelines can influence treatment plans and, potentially, the efficacy and/or tolerance of treatments [22,23]. Nonetheless, several reports have shown that the successful implementation of guidelines and/or shared contouring protocols can result in a significant reduction in inter-observer variability [24–29]. To help address the challenges of contouring, the FALCON (Fellowship in Anatomic deLineation and CONtouring) educational programme was launched by the European Society for Radiotherapy and Oncology (ESTRO) in 2009, and is overseen by the Educational and Training Committee (ETC) of the ESTRO School. This programme uses live and online instruction, and provides hands-on interactive contouring workshops at annual ESTRO meetings, and at clinically oriented ESTRO live courses [30].

Spinal stereotactic body radiotherapy (SBRT) is a rapidly emerging high-precision treatment option in certain clinical situations [31]. Because of the high doses that are delivered and the proximity of critical OARs like the spinal cord, the correct definition of the treatment volume becomes even more important. For these reasons, ESTRO organized 4 live FALCON workshops during its last 2 annual meetings with the aim of improving the contouring knowledge and skills of participants. The aim of this report is to analyse target volume contour data collected during these FALCON live workshops and to show for the first time the pedagogical value of such workshops in improving the homogeneity of participants' contours.

Materials and methods

Materials

We reviewed contouring data from participants at 4 spine SBRT contouring workshops organized during the ESTRO35 (May 2016, Turin, 2 workshops) and ESTRO36 (May 2017, Vienna, 2 workshops) meetings. The case example was based on a patient with

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metastatic non-small cell lung cancer and good performance status, who had a painful, mass-like vertebral metastasis. For the purposes of this analysis, we focussed on the Gross Tumour Volume (GTV) and the Clinical Target Volume (CTV) which the participants were asked to contour on 3 slices of a planning CT scan co-registered with MRI-images. The data of participants who correctly submitted 2 contouring attempts – before and after the teaching – were analysed.

Contouring platform and comparison methods

All workshops were conducted using the web-based EduCase™ platform [32], which provides a graphical interface and allows the management, recording and on- and off-line analysis of the contours. The EduCase™ contour similarity metrics allow the analysis of inter- and intra-observer variation and the overlap (Area of Intersection, AI) of a participant's contours (Delineated Area, DA) with the teaching panel's benchmark consensus contours (Area of Consensus, AC). For the purposes of this analysis, we used the DICE index (DI) to analyse the agreement. The EduCase™ software counted the voxels in each reconstruction plane that contained contours from the panel and participants for a selected structure and calculated DI as $2 \times AI/(AC + DA)$ [33].

Benchmark contours

Three workshop panellists (MD, LS and MG) were identified based on their clinical experience, academic publications, involvement in international guidelines and projects and/or their teaching involvement in the ESTRO School. MG provided a clinical case with contours and the panellists agreed a consensus GTV and CTV contour which was reviewed by BDB prior to the 1st workshop. The approach to contouring was consistent with international consensus guidelines [34].

Workshop structure

A FALCON live workshop lasts 2-h. The spine SBRT workshop was structured as follows (with approximate times):

- A FALCON tutor explained the contouring platform use (10 min).
- The clinical case was presented with all relevant clinical, pathological and imaging information (15 min).
- GTV and CTV were contoured on 3 CT slices by the participants without prior knowledge of the panellist's contours (20 min). Instructors were available throughout this period to help use the contouring platform. Participants also contoured the *cauda equina* and generated a planning target volume (PTV) and planning organ-at-risk volume (*cauda equina* PRV).
- After submission of their contours, participants were shown the anonymized results and variation (10 min).
- Teaching lectures focussed on spine SBRT background; target and OAR contouring followed (30 min).
- Participants re-contoured the same structures which were again saved on the FALCON platform (20 min).
- Participants were again shown the anonymized results and variation (10 min).
- Final discussion (5 min).
- EduCase™ analysis tools were used for a quantitative and a qualitative comparison. Participants were informed during the workshops that the data were saved and available on the FALCON database for analysis and documentation purposes. The analysis was performed with the permission of the ESTRO FALCON core.

Statistics

Participants' contours were evaluated against the benchmark contours. Variation in the DI for specific structures was evaluated before and after the teaching lectures. The Standard Deviation (SD) was used to describe the variability of the measures. The comparison of mean DICE metrics for the first and second attempts was made using Students' *t*-test and a *p*-value of 0.05 to define a significant difference.

Results

There were 66 and 75 participants ($n = 141$) in 2016 and 2017 respectively. 68 (48%) were female and 73 (52%) male. A job description was available for 102/141 (72%): 80 were radiation or clinical oncologists, 19 had a clinical training/assistant or research position and 3 were dosimetrists or therapists. Their country of origin was: Australia and UK = 17 each, Germany and Netherlands = 13, Belgium and Poland = 9, India = 7, Switzerland = 6, Italy = 5, Austria, France = 2, Japan and New Zealand = 4, Ireland and Portugal = 3, Denmark, Hong Kong, Norway, Slovenia, Spain and USA = 2, Brazil, Canada, Egypt, Mexico, Morocco, Russia, Saudi Arabia, Singapore, Sri Lanka and Sweden = 1. Most participants had no prior clinical experience of spine SBRT and no experience of using the EduCase platform.

A total of 94/141 (67%) participants submitted at least one contouring attempt and 58/141 (42%) correctly submitted 2 contouring attempts. Reasons for incorrect submission included submission of only 1 attempt, submission of the same attempt twice or correctly re-contouring of only 1 of the 3 considered slices. There were 141 CT slices for the analysis.

The average DI for GTV, for the whole group of participants was 0.83 (±0.08, SD) before the teaching and 0.85 (±0.08) after ($p = 0.02$). The average DI for the CTV for the whole group of participants was 0.73 (±0.18) before the teaching and 0.9 (±0.12) after ($p < 0.001$). Data are summarized in Table 1 and Fig. 1 shows a GTV and CTV contour before and after the teaching session from one of the workshops.

Discussion

Analysis of contouring data from 4, short, focussed spine SBRT workshops demonstrated a significant reduction in the short-term variability in target volumes definition following an interactive teaching approach using traditional lectures and a web-based contouring/contour-analysis tool. The greater improvement seen in this instance with the CTV is not entirely unexpected: whereas the GTV is consistently used across anatomical sites to refer to the macroscopic disease visible on the scans, the CTV in spine SBRT combines the GTV, with an at-risk, anatomical target volume. This means that the definition of the CTV can vary and it is not necessarily intuitive. It would therefore not be unreasonable to assume that the 1st CTV contouring attempt may be more variable than that of the GTV, and that CTV contouring is more likely to be influenced by the teaching.

Heterogeneity in target volume and OAR contouring remains one of the major uncertainties in modern radiotherapy planning [1,2], is difficult to account for in clinical trials, and impedes the development of evidence-based contouring. However, it is possible to reduce contouring variation through teaching [24–29]. Over the last five years, ESTRO has implemented the online EduCase contouring system as part of the FALCON project [30]. A variety of different resources are now available, aimed at improving contouring skills: live hands-on delineation workshops at the annual ESTRO meetings, hands-on contouring exercises during ESTRO live courses, regular site-specific online/virtual delineation workshops,

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