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References:

Teaching Lecture: Brachytherapy for the pelvic region: status and perspective for the future

SP-0390
Brachytherapy for the pelvic region: status and perspectives for the future - Gynaecology
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Brachytherapy in gynaecological cancers, and especially in cervix cancer, has greatly evolved during the last twenty years. For decades, brachytherapy has relied on x-ray orthogonal acquisitions, and prescription has been a matter of systems and schools, making reporting and comparisons difficult. Based on the developments of afterloaders and treatment planning systems, image-guided adaptive brachytherapy has emerged. This high precision technique combines all modern radiation requirements: image guidance, adaptation to tumor response, and short time treatment.

Ten years ago, the GEC-ESTRO, in a will of harmonizing practices, published recommendations in cervical cancers regarding the definition of target-volumes and the reporting. These recommendations were rapidly adopted worldwide. During the last decade, multiple monocentric series, historical cohorts' comparisons, and a prospective multicentric study (STIC trial) demonstrated high local control rates with a limited morbidity in regard to classical external beam studies were eligible in the review. Initial identification of papers was performed by two large studies led by the Gyn GEC-ESTRO: Retro-EMBRACE and EMBRACE, which will establish MRI-guided brachytherapy as a gold standard.

In addition, clear dose-volume effect relationships have been demonstrated between the modern dosimetric parameters and the probability of achieving local control or facing morbidity. The better knowledge of these correlations allowed the launch of EMBRACE II, a prospective study combing the best radiation modalities (EBRT and IGABT), with optimal and ambitious planning aims. In the near future, the large amount of data collected in the EMBRACE study (> 1 500 patients accrued) will allow the development of monograms integrating not only dosimetric parameters, but also criteria on comorbidities, clinical features, and tumor response to external beam radiotherapy. This would be of great help in adapting and personalizing treatment plans.

Longer-term prospects include the development of alternative image modalities for guidance, such as endorectal ultrasound, cheaper and more accessible than MRI, or conversely, a more advanced and sophisticated image modality.

Image-guided brachytherapy is also progressively declined in other gynecologic tumors, such as vagina cancer or non-operable endometrial cancer.

SP-0391
Brachytherapy for the pelvic region: status and perspective for the future - prostate
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Prostate brachytherapy allows radiation dose escalation directly into the gland with minimal dose to adjacent rectum and bladder. Over the last decade improvements in brachytherapy technology have refined dose delivery with the introduction of HDR after loading devices, more sophisticated treatment planning systems and the incorporation of functional imaging into the planning process. This teaching lecture will provide an overview of the techniques, indications, and clinical outcomes for both permanent and High Dose Rate prostate brachytherapy. Recent results from randomised clinical trials will be critiqued and emerging indications including focal and salvage treatments discussed.

Symposium with Proffered Papers: Adaptive radiotherapy for coping with anatomical variations: hope or hype?

SP-0392
Overview of clinical practice of ART for pelvic tumours
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Introduction: Variation in shape, position and treatment response of both tumour and organs at risk are major challenges for accurate dose delivery in radiotherapy. Adaptive radiotherapy (ART) has been proposed to customise the treatment to these motion/response patterns of the individual patients, but increases workload thus challenge clinical implementation. This presentation presents a review of the clinically implemented ART in addition to in silico workflows that have been published on pelvic tumours.

Material and methods: Initial identification of papers was based on searches in PubMed. For each tumour site (prostate, gynaecological [gynae], bladder, ano-rectal), the identified papers were screened independently by two researches for selection of studies describing all processes of an ART workflow: treatment monitoring and evaluation, decision and execution of adaptations. Both brachytherapy (BT) and external beam studies were eligible in the review.

Result: The review consisted of 43 clinical studies and 51 in silico studies. For prostate, 1219 patients were treated with offline re-planning workflows, mainly to adapt prostate motion relative to bony anatomy. For gynae 1155 patients were treated with online BT re-planning while 25 ano-rectal cancer patients were treated with offline re-planning, all to account for tumour regression detected by MRI/CT. For bladder and gynae, 161 and 64 patients respectively, were treated with library-based online plan selection to account for target volume and shape variations (Figure). In comparison to non-ART, sparing of rectum (prostate and bladder cancer), bladder (ano-rectal cancer) and bowel cavity (gynae and bladder cancer) was reported with ART.
Conclusion: Implementations of ART were dominated by offline re-planning and online BT re-planning, although recently online plan selection workflows have increased with the availability of cone-beam-CT. Advantageous dosimetric and outcome related patterns using ART was documented by the studies included in the review. Despite this, clinical implementations have been scarce, especially regarding prostate and the vast amount of in silico studies available.

Identified challenges hindering successful clinical implementations, were re-contouring of target/OARs in addition to patient selection, aiding the focus of the adaptations to the more challenging patients.

SP-0393
The challenges of ART from a physician’s perspective
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Currently, with our highly conformal modulated radiotherapy techniques, we are capable of delivering high radiation doses to tumour volumes, whilst minimizing dose to the surrounding structures. However, today’s radiotherapy is based on the dogmatic concept of unchanging anatomy of tumors, surrounding normal organs and tissues, where radiotherapy plans solely based on pre-treatment imaging are delivered invariably for several weeks of treatment. Conversely, during a course of curative radiotherapy, tumors and to some extend OARs change. In the field of head and neck cancer, tumor and lymph nodes shrink up to 3% per day, changing size, shape and position. External contour modifications result from loss of weight and muscle mass, altering the geometry of the disease in relation to OARs. This leads to changes in the anatomy of patients, impacting the dose distribution that may differ significantly from what was planned. In this context, considerable efforts have been put on adaptive radiotherapy (ART), i.e. to adapt the treatment delivery on the basis of changes in the tumor and/or normal tissues during the course of radiotherapy. The aim is then to compensate for under-dosage of the target volumes or overdosing of OARs. Re-imaging and re-planning evidently result in an extra workload and cost. Therefore, although ART is an appealing concept, it is at present not used on a routine basis for all patients. The optimal implementation strategy regarding selection of patients and timing of imaging/planning remains to be defined. Several groups are currently investigating these questions, and an overview of the results, from a physician’s perspective will be presented.

SP-0394
The practical “costs” of adaptive radiotherapy
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Adaptive radiotherapy is an emerging area of radiotherapy. In general there are two categories of adaptive radiotherapy leading to either pro-active or reactive adaptations. As the terms suggest, pro-active adaptation is chosen in advance of the patient commencing treatment, whereas reactive adaptation is unscheduled and arises from an unexpected patient change seen during treatment. There are 3 distinct categories for which adaptive radiotherapy approaches should be considered. The categories and most appropriate form of adaptation are given in table 1.

Table 1.

<table>
<thead>
<tr>
<th>Patient Characteristic</th>
<th>Example clinical site</th>
<th>Type of Adaptation</th>
<th>Most likely Adaptive approach</th>
<th>Frequency of adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily anatomy change</td>
<td>Bladder</td>
<td>Pro-active</td>
<td>Based on small number of pre-determined options</td>
<td>Daily</td>
</tr>
<tr>
<td>Slowly changing anatomy over treatment course</td>
<td>Head &amp; Neck</td>
<td>Pro-active</td>
<td>Modified treatment plan based on new patient anatomy information</td>
<td>Weekly</td>
</tr>
<tr>
<td>Unexpected anatomy changes</td>
<td>Any</td>
<td>Reactive</td>
<td>Modified treatment plan based on new patient anatomy information</td>
<td>Unscheduled</td>
</tr>
</tbody>
</table>

Studies of safety in radiotherapy have shown that there is a higher risk of deviation during handoffs between staff groups with tight coupling and when decisions are made under significant time pressure. Deviation rates of <0.5% per fraction have been reported1-5, leading to deviation rates in the range 1-2% per patient. Adaptive radiotherapy can be seen as increasing the complexity of handoffs and creating more frequent decision making points in the process under time pressure. In this context the introduction of adaptive radiotherapy needs to be made whilst mitigating the risk of significantly increasing deviation rates.

Justification is required for adaptation from the assessment of risks and benefits from adaptive approaches. As there is currently no clear clinical benefit from adaptive radiotherapy, new risks need to be mitigated to ensure there is an overall patient benefit. Once procedures have been developed for an adaptive approach, changes in personnel, training and workload are likely to be needed to ensure the safe use of adaptive radiotherapy. For example, there are significant training requirements for radiotherapy treatment staff when applying pro-active adaptive radiotherapy techniques where the most appropriate plan must be chosen at each treatment fraction.

Reactive adaptation has organically arisen from the routine use of online image-guidance. For example using cone-beam-CT has provided a wealth of information regarding patient anatomy changes during the course of radiotherapy. Inevitably changes in patient anatomy seen during treatment lead to questions regarding the appropriateness of the original treatment plan. It is likely that around 20% of patients receiving radiotherapy will have anatomy changes requiring assessment for appropriateness of their original treatment plan during the course of their treatment. However, modifications to treatments should only be enacted if the patient benefit from the change outweighs the risk of a deviation that could lead to worse patient outcome. Applying this approach is likely to lead to <5% of patients requiring a modification to their treatment. Therefore, at the very least, departments will require efficient processes for the review of treatment plans against changes to patient anatomy.

In conclusion, currently the clinical justification for adaptive radiotherapy approaches is unclear but the adoption rate is likely to continue to rise due to the available technology. In this context there is a requirement to ensure staffing.