Challenges and pitfalls of vaginal cancer image guided adaptive brachytherapy

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Introduction: Brachytherapy (BT) is an essential part of vaginal cancer treatment. In 4D image guided adaptive BT (IGABT), the dose distribution is adapted to a target which changes in shape and volume during the course of therapy, while respecting the organs at risk (OAR) dose constraints. IGABT has improved the outcome of vaginal cancer. Several challenges and pitfalls of this approach were recognized, in particular (but not limited to) uncertainties of various steps of IGABT procedure, limited sectional imaging availability and complexity of application techniques. Some of the main challenges, pertaining specifically to vaginal cancer, are discussed below.

Application techniques: Various application techniques have been used for vaginal cancer BT in the past. Implementation of sectional imaging enables detailed assessment of the patterns of tumor spread, regression and topography at IGABT. Based on such evaluation, development of innovative vaginal BT applicators and refinement of application techniques represents a challenging avenue of future research. Off-line or real-time intraoperative MRI or ultrasound guidance is a promising approach that has proven helpful in achieving optimal interstitial implant geometry in vaginal cancer [Stock RG, et al. IJROBP 1997, Weihebert MD, et al. Strahlethehrt Oncol 2006, Viswanathan AN, et al. IJROBP 2006].

Implantation techniques: Various target volume concepts, contouring and dose volume parameters: Technical precision of treatment delivery has likely surpassed our ability to estimate the location of tumor spread, meaning that contouring uncertainties may compromise the overall gain of IGABT [Petric P, et al. RadiotherOncol 2013, submitted]. Optimal imaging, adequate training and respecting the contouring guidelines are the main strategies to minimize these uncertainties. MRI has been recommended as the gold standard for cervix cancer IGABT. In the absence of specific guidelines, the GEC ESTRO recommendations for cervix cancer IGABT may be applied in vaginal cancer with some adaptations [Dimopoulos JC, et al. IJROBP 2012, Petric P, et al. in: Viswanathan et al., eds. Gynecologic radiation therapy, Springer 2011, Pöött R, et al. Radiother Oncol 2006, Häise Meder C, et al. Radiother Oncol 2006], Dimopoulos et al. applied these concepts in 13 vaginal cancer patients and found the dose-volume parameters and clinical outcome to be in a range, comparable to experience in cervix cancer [IJROBP 2012]. The validity of this approach would benefit from confirmation in further studies. Limited availability of MRI remains a limitation for wider implementation of IGABT [Guedea F, Radiother Oncol 2007] and fuels the ongoing efforts to systematically validate the role of ultrasound and computed tomography in this field.

Clinical outcome: Reports on clinical benefits of vaginal cancer IGABT have been published [Dimopoulos JC, et al. IJROBP 2012, Dimopoulos JC, et al. Onkologie 2009, Viswanathan AN, et al. IJROBP 2006, Weihebert MD, et al. Onkologie 2006]. However, they are limited to small retrospective series and the evidence for vaginal IGABT is mainly based on extrapolations from larger studies in cervix cancer. Importantly, the specific relationships of vaginal tumors to the nearby organs at risk represent a somewhat different challenge than in cervix cancer. The ability to preserve vaginal anatomy and function, integrated with the combination of external beam radiation and interstitial brachytherapy, has important quality of life implications. The role of concurrent chemoradiotherapy and adjuvant systemic therapy in vaginal cancer has not been tested in clinical trials. These topics are gaining increased attention in cervix cancer IGABT and should be addressed also in vaginal cancer IGABT.

Conclusion: The IGABT concepts, developed for cervix cancer, appear to be applicable to vaginal cancer with some adaptations. Prospective multicenter studies are needed to further establish the impact of IGABT on treatment outcome and any possible influence on quality of life issues, but will be challenging to conduct due to the low incidence of this disease.