Interventional Oncology: Should Interventional Radiotherapy (Brachytherapy) be Integrated into Modern Treatment Procedures?

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OBJECTIVE
The delivery of a very high dose by radiotherapy to a dedicated target with minimal surrounding normal tissue dose is a challenging situation. From a radiotherapy point of view, in several anatomic situations, the most optimal method is the use of interventional radiotherapy (brachytherapy; IRT) alone or in combination with other established interventional tumor cell eliminating methods.

METHODS
First, Interventional Radiotherapy, Interventional Radiology, Interventional Endoscopy and Interventional Chemotherapy have the same aim of eliminating tumor tissue. Second, target definition and some IRT application techniques need multidisciplinary teamwork.

RESULTS
Multidisciplinary teams have the best potential to offer the best possible cure in localized solid tumors or in selected oligometastatic disease. Examples for this kind of service are given for H&N-, anal-, vaginal-, breast-, prostate cancers as well as in oligometastatic disease. The combined use of interventional tumor ablation techniques is demonstrated.

CONCLUSION
Interventional Oncology has the potential to improve the treatment results in localized solid cancers or in selected oligometastatic disease, and large workload Interventional Oncology Centers could have an important role in the patient service, in the education as well as in the clinical research.

Keywords: Brachytherapy; interventional oncology; interventional radiotherapy; multidisciplinarity; personalized medicine; world-class medicine.

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Introduction

The delivery of a very high dose by radiotherapy to a dedicated target is a challenging situation. The cooperation between different experts, like diagnostic and interventional radiologists, surgeons, endoscopy experts and radiation oncologists improve the accuracy of target definition [1-6] and it offers the possibility to create the best possible implant geometry with or without surgical tumor tissue removal.[7,8]

Interventional radiotherapy (brachytherapy; IRT) represents the optimal method for applying a high radiation dose conformity within the target volume with rapid dose fall-off in adjacent organs at risk, relatively short treatment times and good functional outcomes.[7,9,10]

Materials and Methods

Interventional Radiotherapy, Interventional Radiology, Interventional Endoscopy and Interventional Chemotherapy have the same aim - the elimination of tumor; accompanied with minimal surrounding normal tissue injury.

The ablation target definition is based on up-to-date imaging methods, as well as the IRT application techniques need multidisciplinary teamwork.

Results

Multidisciplinary teams have the potential to offer the best possible cure in localized solid tumors as well as in selected oligometastatic disease. Examples for this kind of service are given for H&N-, anal-, vaginal-, breast-, prostate cancers and in oligometastatic disease. The combined use of interventional tumor ablation techniques are demonstrated. Interventional Oncology has the potential to improve the treatment results in localized solid cancers or in selected oligometastatic disease.

Discussion

Modern oncology offers personalized treatments. The choice of the best possible treatment should be based on multidisciplinary discussion [11] focusing to efficacy, feasibility and costs benefit but also considering the patient's age, clinical condition, presentation of disease and patient's particular needs (travel, work, family). A radiation oncologist usually needs additional experience of other specialty representatives in these decisions as well as in the procedure performance.

In head & neck cancers (H&N) the cooperation of representatives of imaging experts (diagnostic radiology, nuclear medicine), H&N surgery, dento-maxillary- and plastic surgery, neurosurgery and external beam radiotherapy (EBRT) as well as of interventional radiotherapy and medical oncology is mandatory.[8,12-15] In prostate cancer treatments IRT experts need the additional experience of a radiologist to perform staging investigations+mpMRI (for defining the dominant intraprostatic lesions), the urologist, who has as central role in the patient selection (biopsies, IPSS, uroflow, residual urine volume definition, as well as performing the follow-up). If biological planning is applied, experience with mpTRUS (multi-parametric transrectal ultrasound) is necessary in the real-time planning procedure. [4,16-20] Furthermore, in many situations, the medical oncologist can offer invaluable help in systematic treatment decisions. Additionally, we need the cooperation of a pathology and anesthesia expert.[21] In anal and vaginal cancer IRT usually transrectal and/or transvaginal ultrasound implantation guidance is used. The knowledge of a proctologist/gynecologist is necessary for optimal orientation and performance of the implantation technique, as well as the presence of an anesthetist at the implantation procedure is obligatory.[22-24] In breast cancer IRT, independently from the fact of a planned partial breast or boost implantation, multidisciplinary decision-making is obligatory. The cooperation of imaging experts, pathologists, breast surgeons and IRT/EBRT experts offers the best possible treatment results.[25-27]

Nowadays, many minimally invasive procedures are spreading in the oncological management especially for elderly or frail patients.[28,29] There are different kinds of interventions to treat localized malignancies or oligometastatic disease. These can be collected under the name "Interventional Oncology". The four identified main interventional fields (Interventional Radiotherapy, Interventional Radiology, Interventional Endoscopy and Interventional Chemotherapy) focus to the same aim of eliminating tumor tissue with maximal possible normal tissue; as well as function preservation. Many procedures could be proposed alternatively among them and only a detailed case evaluation and multidisciplinary discussion can result in the offer to the patient regarding the best therapeutic choice. The described procedure determines the need for multidisciplinarity and an "Interventional Oncology Center (IOC)" could offer a possible solution. The IOC is an "interdisciplinary service for diagnosis and
treatment of cancer and cancer-related problems using targeted (focal) minimally invasive procedures’ and should have the possibility to evaluate every patient by an IRT expert, an interventional radiologist and an interventional endoscopy specialist.

There are different endovascular focal treatments and percutaneous interventional tumor ablation methods by the team members available: trans-arterial chemo-embolization (TACE), trans-arterial radio-embolization (SIRT), microwave ablation, radiofrequency ablation, and cryotherapy. The specialty of radiotherapy offers IRT or electro-chemotherapy (ECT) for local treatments.[30] In there recent literature all of these interventions were published with good results; however, comparative studies are very rare.[9,31-33] Treatments with favorable outcome were reported in different anatomic sites like head & neck-, bone-, liver-, soft tissue- and peripheral lung tumors or oligometastes.[9,34-40] Recently, the advantage of a robotic implantation with the use of a personalized 3D printed template compared to the manual implantation with personalized 3D printed template guidance was documented.[41] Some groups use seed implants, other the HDR stepping source technology. In HDR practice, dose distribution can be better personalized by adjusting dwell times and dwell distances, which allow conformal radiation delivery. This tool can best used if the implant geometry is optimal and the one doesn’t need to use the optimization tool to compensate for poor catheter geometry and minimize radiation dose to adjacent OARs. Furthermore, without taking in account the different biological dose needs of the targeted tumor (hypoxia, stem cell density, etc.), improved tumor control from dose intensification will always come at the penalty of higher early- and late toxicity rates. A potential way to avoid this is to use techniques to focus the escalated dose to the high-risk regions.[18,20,16] Additionally, in a high workload IRT department HDR brachytherapy treatments are more economical.[42-44] Added value is the advantage of IRT using the possibility of multiple and repeated applications due to the small volume normal tissue irradiation.[45]

Since reports about patient cohorts treated by multidisciplinary IRT are rare, the creation of international large databases and their analysis could help to find high level evidences in the future.[46-48] Moreover, we need educational centers focusing to world-class medicine by multidisciplinary decision-making and multidisciplinary treatment performance.[49] The future belongs to multidisciplinary type of treatments-as documented with the following case: The liver metastases of a colon cancer were cured in the right lobe with the applied TACE (trans-arterial chemo-embolization); however, there was a residual due to the vascular supply from the infiltrated diaphragm. The residual was treated with a single-shoot 20 Gy HDR-IRT. In the post-treatment imaging a vital rest of the metastasis was detected and finally treated successfully with MWA (microwave ablation). (Figs. 1-4). Multidisciplinary treatments should be performed on the highest level of performance quality; however, standards are only of value if they are implemented, reviewed, audited and improved and if there is a clear mechanism in place-to monitor and address failure to meet agreed standards.[50] The optimal places to realize it, are dedicated Centers of Excellence.[51] In Centers of Excellence is possible to collect an appropriate number of trained staff, to participate in clinical trials, as well as to introduce a safety culture with reporting and learning systems in place to support learning from incidents and errors of all procedural levels. An additional advantage is if different Centers of Excellence are cooperating in a dedicated network on the national and on the international level. The key issues for moving towards a world-class service requires changes in work culture as well as in work organization: Optimizing of the planning across patient pathways, Regular multidisciplinary tumor board discussions to offer the highest quality of personalized medicine, Strengthening of multi-disciplinary team work in diagnosis, treatment, quality assurance and research, Co-ordination of the referral system, which is disseminated down to home

Fig. 1. Case presentation, part A.
IRT represents approximately 15-25% of the workload of a large radiotherapy department [52], therefore it seems to be an advantage if specialized regional IRT centers would serve a larger region in a network and in close cooperation with the participating radiation therapy departments. On this way, the heavy workload and the variety of anatomic sites allow efficient education and clinical research work on the topic.

**Conclusion**

Multidisciplinary Interventional Oncology (MIO) has the potential to improve the treatment results in localized solid cancers or in selected oligometastatic diseases with healthcare economical advantages. An Interventional Oncology Centre with a large workload could play an important role in the patient service, in the education as well as in the clinical research.

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**References**


**Fig. 2.** Case presentation, part B.

**Fig. 3.** Case presentation, part C.

**Fig. 4.** Case presentation, part D.

doctor level, Adequate and continous teaching activities on an up-to-date level by the use of latest informatics technology.


