Paediatric radiotherapy – practical treatment planning aspects

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Background
Approximately 250 children and adolescents in Sweden are diagnosed with cancer each year. About 100 of these will receive radiotherapy as part of their treatment. A large fraction of the children are cured and become long-term survivors. The overall survival of children with cancer (all forms) in Sweden in 2011 was approximately 80% [1]. Hence, the aim of treatment must be optimized in order to minimize the long-term side-effects of treatment, which today mostly is a combination of surgery, chemotherapy and radiotherapy. Paediatric radiotherapy (RT) is presently available at the University Hospitals in Gothenburg, Linköping, Lund, Stockholm, Umeå and Uppsala. Between 5 and 30 children are treated annually at these centres. Since it’s a small group of patients at most hospitals, and few radiation oncologists with an interest in paediatric radiotherapy, it is difficult to maintain a high competence in the area. A Swedish working group, consisting of physicians and medical physicists, collaborating on matters concerning treatment of children with radiotherapy, was formed in 2002. The members of this group are also active in other working groups dealing with issues regarding childhood cancer. The “Swedish Workgroup for Paediatric Radiotherapy” is fairly small, including only one or two physicians from each University Hospital (together with a few medical physicists). An important collaboration is with the so called Radtox registry and its international partners (Germany, Norway and Denmark). The Radtox registry was started in 2008 and includes detailed radiotherapy data for paediatric patients in Sweden. The purpose with the registry is long-term follow-up after RT, with the aim to decrease long-term side-effects of RT. Another challenge in paediatric RT is the start of the Swedish proton centre; Skandionkliniken at which a majority of the paediatric cohort is expected to be treated.

Problem investigated/Method
Paediatric radiotherapy is available at few hospitals and with few involved radiation oncologists. Therefore we investigated, if and how telemedical conferences could improve the quality of paediatric radiotherapy. The purpose was to raise and keep competence in the field of paediatric radiotherapy. We started the videoconferences in 2005. Prior to the start we examined the participants’ views on needs and expectations. This investigation was repeated and evaluated after one year of bi-weekly telemedical conferences (Paper 1).

During these conferences target volume extensions were often discussed. This led to a workshop to discuss target delineation and the adherence to treatment protocols for selected patient cases. Targets and organs at risk were delineated, and treatment plans created. We compared volumes and relevant dose descriptors (Paper 2).
A new treatment modality is now being introduced in Sweden, i.e. proton therapy, where correct target and planning target volume segmentation is even more crucial than for photons. The possibility to treat with protons is favourable for many children compared to photons. In a treatment planning study we investigated and quantified the gain of proton compared to photon radiotherapy for a cohort of patients with various diagnoses (Paper 3).

**Results**

The development and implementation of telemedical conferences has led to that they are now part of the clinical routine, were all new paediatric cases for radiotherapy are discussed. The needs stated before the start of the project on both technical issues as well as issues on competence have been fulfilled. We found large variation in target delineation between the five participating centres/radiation oncologists while the segmentation of organs at risk had a high concordance. Target conformity indices ($C_{\text{gen}}$) for these target volumes were in the range of 0.4 to 0.6 (should optimally be 1.). The treatment planning comparison of protons and photons resulted in a general gain especially in irradiated volumes with an advantage for protons. This was seen for most cases, but most clearly for brain tumours. However we also noted a few cases where no gain was found.

**Future perspectives**

With the national teleconferences as a platform, we can continue to improve radiotherapy protocols to make them more ambiguous in order to improve the segmentation of target volumes. Collaboration between centres is then necessary. This is especially important for proton therapy as many of Sweden’s children and adolescents requiring radiotherapy in the future will receive their treatment with protons. To further investigate the effects and side effects of radiotherapy, any modality, the Radtox registry will be able to give some answers. In order to do that we have to assure that the data we enter are of good quality. This will be investigated in study IV.

- Paper III - Comparative proton and photon treatment planning in paediatric patients with various diagnoses. Kristensen I, Nilsson K, Nilsson P. Accepted for publication in Int. J of Particle Therapy (Aug 2015)