COMPARISON OF OPTIMISED TREATMENT PLANS
FOR RADIOSURGERY AND CONFORMAL RADIOTHERAPY

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Abstract - The aim of conformal radiation therapy and of radiosurgery (Gamma Knife and Multi-beam radiosurgery) is to irradiate the pathological target volume with ionising radiation while avoiding as well as possible the surrounding normal tissues. Considering the accuracy of these treatments, it is interesting to compare the different techniques to evaluate their effectiveness. This comparison involves 8 clinical cases. For each treatment modality, we compare indexes defined in the international literature by the Radiation Therapy Oncology Group (RTOG). This theoretical study shows (i) the interest of the use of intensity modulation in the case of conformal radiation therapy and (ii) the improvement of RTOG indexes with using the conformal radiotherapy although the VNT25% and the VNT50% remains better with the radiosurgery.

Keywords - Conformal radiation therapy, Radiosurgery, Treatment planning, Optimization,

I. INTRODUCTION

The radiosurgery concern is the treatment of small lesions in the brain. The immobilization of the patient is obtained by a stereotactic frame. The convergence of a great number of beams in a point makes it possible to obtain an high dose and high gradient of dose, while keeping low intensity delivered by each beam. Intensity is thus distributed on a great number of beams to reduce the dose received by normal tissues and by organs at risk. Among the techniques used in radiosurgery, this work relates to two techniques: Knife Gamma and multibeam stereotactic radiosurgery.

Gamma Knife (GK) (Fig.1) uses the convergence of beams resulting from 201 radioactive sources of Cobalt 60 focused in a point: the shooting center. Each source can be blocked by a plug to avoid intersection with an organ at risk. The collimation of the beams is done using circular collimators of various diameters (4, 8, 14 and 18mm). These collimators are placed on a removable helmet fixed on the head of the patient by the way of the Leksell stereotactic frame. Generally, the helmet consists of the same size collimators.

The multibeam stereotactic radiosurgery (SRS, Fig.2) uses X-rays from the linear accelerator (LINAC). The irradiation is carried out in a continuous way following of non-coplanar arcs. These arcs are obtained thanks to the movements of the accelerator and the support of the patient (bed or seat) on whom the head of the patient is immobilized using the stereotactic frame. The collimators are circular, the diameter of which varying from 6 to 25mm by step of 2mm and one collimator of 25 mm diameter.

For the conformational radiotherapy, the micro multileaf collimator used is the ConforMAX™ Radionics® (Fig.3). This collimator (µMLC) is composed of 31 pairs leaves
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Abstract

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(4mm width at the isocenter). The dose calculation is obtained by a method of decomposition in elementary pencil beams of 2x4mm size. For the realization of a treatment plan, the number of fields is chosen by the user, the orientations of these fields are optimized by a genetic algorithm and the other parameters (i.e. positions of the leaves, field intensities, elementary pencil beam in the case of IMRT) are given by a simulated annealing method.

We compared the treatment planning optimization results of the 3 techniques on 8 clinical cases: 3 meningiomas, 3 metastases, and 2 acoustic neurinomas. For each volume, the prescribed dose is fixed at 70% with a maximum dose of 100%. The first two protocols relate to the radiosurgery with GK and SRS. The last relates to the conformational radiotherapy with the µMLC, and in this case 5 fields with modulation of intensity for the µMLC makes it possible to improve conformity compared to the other techniques (GK and SRS). However in the case of the µMLC radiotherapy, the irradiation dose fractionation allows the regeneration of healthy tissue, and thus avoids tissue necrosis. In addition, radiosurgery techniques (GK and SRS) are very effective for the small target volumes, but they can involve an important overdosage in the case of complex and large volumes. This overdosage appears especially when numerous isocenters are used. Even if these results remain to be validated in the case of the µMLC, the comparison between the three types of treatment makes it possible to consider in certain cases substitution of usual radiosurgery by irradiation treatments carried out with an µMLC.

### TABLE I

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<th>Type of treatment</th>
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<tr>
<td>µMLC</td>
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<td>100.1</td>
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### REFERENCES