

Preface

Since the inception of the modern era, with the lengthening of life expectancy, cancer has represented one of the most common causes of death worldwide, also the most striking challenge to modern medicine.

Throughout the centuries, together with the deepening of our understanding in biology and human anatomy, numerous steps have been made in the comprehension of this complex and vast pathology. As a result, increasingly effective diagnostic methods and treatment techniques have been developed.

Particularly in the past decades, new discoveries in chemistry and nuclear physics brought groundbreaking advances to this field.

The detection of so-called “tumoral markers” in the blood, or today’s imaging techniques (CT, NMR, SPECT, PET) paved the way to early and precise diagnosis of tumors, while chemotherapy and radiotherapy provided treatment options of fundamental importance.

Despite all this progresses, still today this battle is far from being won.

As surgery being the principal treatment used for cancer, several techniques and technologies are being developed in order to improve its effectiveness, mainly by enhancing the completeness of the tumor resection.

In particular, in this thesis, RGS is discussed. In this approach, a certain amount of a radiopharmaceutical, which is preferentially absorbed by the tumor, is administered to the patient before the surgical intervention. Using a dedicated detector, capable of revealing the particles emitted by the radiopharmaceutical, the surgeon can scan the tumor site looking for residuals of the lesion after the removal of the bulk neoplastic mass.

Despite this technique being fairly widespread today, its applicability is restricted by a number of serious limitations.

In order to overcome such limitations, a novel approach is proposed in this thesis, exploiting β^- radiation in place of β^+ and *gamma*, the ones used today.

In Chap. 1 an overview of the existing techniques of support to surgery is given, highlighting each one’s strengths and weaknesses. Possible further developments are then discussed, focusing on β^- -RGS.

In Chap. 2, the FLUKA Monte Carlo code is presented, which was used throughout the thesis to integrate and understand experimental measurements and clinical data.

In Chap. 3 the development of the probe to be used for β^- -RGS is discussed, starting with laboratory measurements and ending with the presentation and testing of the first probe prototypes.

In Chap. 4 the possible medical applications for such technique are discussed, in particular regarding brain surgery and neuroendocrine tumors, presenting the results of two statistical studies carried out on DICOM images of the patients affected by these diseases.

In Chap. 5, further studies exploiting both data and simulations are presented in order to evaluate the performance of the probe prototypes in real clinical scenarios, and an evaluation of the radio exposition of the medical personnel during an RGS procedure is obtained by a Monte Carlo simulation.

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