

Preface

Initial Considerations

After the publication of my book *Hadron Therapy Physics and Simulations* by Springer in 2014, I was encouraged to publish another text showing the advantages, disadvantages, and similarities between protontherapy and the carbon ion therapy. Even though no carbon ion therapy centers currently exist in the United States, a large number of protontherapy centers do. Still, the topic is timely as the installation of carbon ion therapy centers is being considered.

An international interchange was established with Japan (National Institute of Radiological Sciences, NIRS) and Germany (Heidelberg Ion Beam Therapy Center, HIT) during the 2013 Joint Symposium on Carbon Ion Radiotherapy, developed by the Department of Radiation Oncology, Mayo Clinic and research collaborations between the National Institutes of Health (NIH)/HIT and Colorado State University/NIRS. As a result, \$200 million in grant funding was obtained for the installation of a carbon ion therapy center at Colorado State University and the formation of a consortium in Michigan with similar proposals. After all, carbon ion therapy was born in Berkeley and was taken to Chiba, Japan, by Japanese intern researchers from Berkeley.

The success reached with this technique drove the Germans to form HIT, with a 670 ton gantry, using the intensity-controlled raster scan method, gating, local effect models, and all the available resources in Oncology, obtaining excellence in fundamental and clinic research, in association with researchers from Gesellschaft für Schwerionenforschung in Darmstadt. This was an absolute success, with a large research field. There are currently 15 ongoing clinical trials in protontherapy and carbon ion therapy.

Carbon ion therapy is a promising technique. Certainly, the current approaches will be obsolete in the future due to the development of experimental work committed to evolving the technique and achieving important clinical results to benefit patients with cancer. Therefore, this book provides the reader with a comparative

analysis between protontherapy and carbon ion therapy, thanks to a broad field of research and existing studies in the literature. It is our responsibility to expand on these achievements in order to save lives.

About This Book

This book compares and contrasts the approach, advantages, disadvantages, and indications for protontherapy and carbon ion therapy. To reach these conclusions, a broad search of the literature was performed, resulting in concise information presented here in five chapters.

Chapter 1 begins with a brief history of radiotherapy and types of radiation. Then, the attention is focused on cancer in a statistically comprehensive way with a global view. Conventional radiotherapy is still widely used, especially in developing countries that lack the financial resources to buy equipment for nonconventional radiotherapy. If the price of a cyclotron or synchrotron was close to a linac, no one would use conventional radiotherapy. However, South America, for example, has no nonconventional radiotherapy equipment, although a protontherapy center provided by Ion Beam Application (IBA) is being installed in Central America (Panama).

Chapter 2 analyzes the equipment and techniques with regard to conventional equipment, hybrid systems, more advanced models, and new equipment in development, such as the cyclinac, laser, and Dielectric wall accelerators (DWA). If the expected success is obtained, these developments will lead to a significant price drop, as well as more operational facilities. A hadron therapy simulation technique is also presented in this chapter.

Chapter 3 of this book focuses on biophysical and biological properties, which are fundamental in both experimental and clinical areas. Chapter 4 presents models for determining relative biological effectiveness. Finally, Chap. 5 discusses clinical experiences with carbon ions, covering the latest literature and presenting its advantages, disadvantages, similarities, and indications for therapy with carbon ions in comparison with protontherapy.

It is hoped that this book will provide the reader with the knowledge to analyze promising techniques using carbon ions, allowing you to draw your own conclusions. Much effort is required for the development of the technique, its comparative protocols, and clinical trials. In the future, even if the considerations presented in this book are deemed obsolete, it is my hope that this book has helped to establish new therapy centers for carbon ions and thus save lives.

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