Basic Press Map

MedAustron Center for Particle Therapy and Research

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In a Nutshell

MedAustron is a unique cancer treatment and research center in Austria and one of only six comparable centers worldwide. Cancer patients receive help there with an advanced and one of the least available therapies, ion or particle therapy. This form of radiation therapy uses charged particles - protons or carbon ions - to treat tumors. In addition to clinical applications, MedAustron also conducts research to improve the therapy method and generate more evidence. MedAustron has been in operation since December 2016.

What is Ion or Particle Therapy?

Particle therapy is a highly precise form of radiation therapy in which beams of high-energy protons or carbon ions are used to treat cancer. In contrast to X-rays (= photons) or electrons used in conventional radiation therapy, these particles deposit the maximum radiation dose in the last millimeters of their path and thus directly in the tumor. The underlying physical phenomenon is called "Bragg peak". Because of this effect, it is possible to minimize radiation exposure to the healthy tissue around the tumor, making particle therapy an ideal method for treating tumors close to radiation-sensitive organs. Side effects and long-term effects of radiation therapy can be reduced.

More than 300,000 patients worldwide have already been treated with particle therapy, and for many indications it is already an established form of therapy. More than 100 clinical trials are currently underway to evaluate further indications, the most suitable subgroups of patients, or the reduction of long-term side effects.

Protons and Carbon Ions

Particle therapy uses protons or carbon ions. The former are more widely used worldwide because of the more easily available equipment, while the latter require more complex technical equipment. Both particles possess the advantage that the radiation exposure in healthy tissue can be kept low. Carbon ions, however, additionally have a higher biological effectiveness, unleashing even more destructive power in tumor cells. Even small doses of this radiation can break chemical bonds, change the shape of molecules and destroy DNA. Because cancer cells have inadequate repair mechanisms for this damage caused by carbon ions, it can also be used to combat particularly difficult-to-treat tumors that do not respond to other types of radiation, for example. Worldwide, carbon ions are currently used in only about 13 percent of all patients treated with particle beams - a logical consequence of the technology's limited availability. MedAustron is the sixth in the world - along with centers in Germany, Italy, Japan and China - to be able to use both types of particle for therapy.

Which Types of Cancer Are Treated With Ion Therapy?

Particle therapy is mainly used for tumors that are localized and for which a cure or at least long-term survival can be achieved by local tumor cell destruction.

The spectrum of indications treated is growing steadily: while in the beginning it was mainly rare tumors such as sarcomas or skull base tumors, the therapy is being increasingly used for more common cancers - from ENT tumors to abdominal tumors and pelvic tumors.

Proton therapy is particularly suitable for children and adolescents. In this patient group, it is extremely important to both concentrate radiation dose in the tumor to reduce the risk of a recurrence and to minimize radiation of any kind to minimize severe permanent damage to still-developing tissue. Proton therapy can significantly reduce the side effects of radiation therapy and thus greatly improve the quality of life of pediatric or adolescent cancer patients. Children have been treated with protons since the 1990s.

Another important application of particle therapy is recurrences - tumors that grow again after conventional radiation therapy. In these cases, the options for re-irradiation are very limited; particle therapy represents a real chance for these patients.

Patients are treated on an outpatient basis at MedAustron. Daily irradiation takes place over several weeks. The duration of treatment varies individually between one and eight weeks.

What is being researched at MedAustron?

Clinical Research

The majority of all patients at MedAustron participate in a registry study to prospectively collect data. This includes tumor control and side effects as well as the patients' quality of life. In addition, disease-specific studies are continuously being developed. MedAustron also actively participates in international clinical trials.

Interdisciplinary oncological research

With the two divisions of radiation oncology and medical physics located at MedAustron, the center is also a teaching and research site of the Karl Landsteiner University of Health Sciences in Krems. The overall aim of the oncological research activities at KL is to use the findings from basic, translational and clinical research directly for the benefit of patients and to advance new individualized treatment procedures in systemic cancer therapy and ultra-precise radiotherapy.

Translational Research

Research topics that are close to medical application are classified as translational research Interdisciplinary and integrative research combining physics, biology, computer and medical sciences is reflected in the research program. Currently compiled for the period 2022 - 2024, it spans the areas of Applied Particle and Medical Physics, Biophysics and Molecular Radiation Biology, Technical Innovations and Clinical Implementation, and Accelerator Physics.

The priorities set both reflect the prioritized topics of ion beam research across Europe and also take into account the clinical needs at MedAustron by being fully in line with the roadmap for the introduction of new indications.

The research projects are currently carried out mainly in cooperation with the Medical University of Vienna and the Vienna University of Technology. In addition, there are also close collaborations with the University of Applied Sciences Wiener Neustadt, the Institute for High Energy Physics of the Austrian Academy of Sciences and the Medical University of Graz.

A special feature of the MedAustron center is that a dedicated irradiation room is available for non-clinical research.

The Technical Facility at MedAustron

To be able to generate different types of charged particles for therapy and research, a synchrotron-based facility is required. This is a type of ring-shaped particle accelerator developed by MedAustron in close cooperation with CERN.

Three ion sources produce the particles used for irradiation at MedAustron: Carbon dioxide CO_2 or hydrogen gas H_2 is heated to extremely high temperatures, creating a plasma. Electric fields separate the positively charged ions from the negatively charged electrons from this plasma.

The first stage of acceleration to about 12% of the speed of light then takes place in a linear accelerator. In the next step, the ions are injected in the synchrotron to a circular path with a length of about 80 meters, in which strong magnetic fields deflect the charged particles and accelerate them step by step with each pass. Speeds of up to 2/3 of the speed of light are achieved in the synchrotron.

In medical operation, the MedAustron facility enables an energy range of 60 to 250 MeV for protons and 120 to 400 MeV/u for carbon ions. For non-clinical research, proton energies up to 800 MeV are available. The energy of the particles corresponds to the penetration depth of the beam into the body, with a maximum of 30 centimeters.

MedAustron has four irradiation rooms, three of which are used for patient treatment and one for non-clinical research. All four rooms are equipped with identical medical technology.

An essential factor of the treatment is the exact positioning of the patients. MedAustron has a positioning system that is unique in the world: a ceiling-mounted robotic system makes it possible to align patients with the therapy beam with an accuracy of half a millimeter and to ensure exact positioning throughout the treatment.

Immediately before each radiation fraction, the Imaging Ring System (IRS) verifies the correct position of the patient. The IRS is mounted directly on the patient table and consists of an X-ray tube and a detector. The components can rotate independently of each other and be moved in a horizontal direction. The three-dimensional images of the tumor position thus obtained are used for precise positioning of the patient during treatment.

The MedAustron Team

Currently, about 250 employees from 20 different nations work at MedAustron. Around 50 of them previously worked for MedAustron at the European nuclear research center CERN in Switzerland.

Typical job profiles at MedAustron are physicists, technicians from various disciplines, specialists in radiation oncology, medical physicists and radiation technologists.

Management

Mag. (FH) Ludwig Gold
Prof. Dr. med. Eugen B. Hug

MedAustron in Figures

- 200,000 kilometers per second
  are reached by the particles used for irradiation.
- 200 million euros
  were the investment costs for the center.
- 6 centers worldwide
  currently offer therapy with both protons and carbon ions.
- 1,000 different components
  from more than 200 manufacturers from over 20 different countries are installed in the accelerator.
- 20 nations
  are the home countries of MedAustron employees.
- 32.200 m²
  is the size of the site on which the MedAustron building is erected.
- 12,000 kilowatts
  is the electrical connected load for MedAustron.
- 200 kilometers of
  of power cables have been laid.
- 10,000,000,000 = 10^{13} protons
  are needed on average for one patient treatment.

Current Developments

At MedAustron, patients are currently treated in three radiation rooms. In addition to clinical operations, technical development as well as non-clinical research, takes place at night and on weekends. From a clinical point of view, the constant goal is to increase treatment capacities on the one hand and to expand the range of indications on the other. Technically, an important focus is on preparing the facility for the application of helium ions as a third type of particle.