Particle therapy

Particle therapy is a form of external beam radiotherapy using beams of energetic protons, neutrons, or positive ions for cancer treatment. The most common type of particle therapy as of 2012 is proton therapy. Although a photon, used in x-ray or gamma ray therapy, can also be considered a particle, photon therapy is not considered here. Additionally, electron therapy is generally put into its own category. Because of this, particle therapy is sometimes referred to, more correctly, as hadron therapy (that is, therapy with particles that are made of quarks).

Neutron capture therapy might be considered a type of particle therapy, but it is not discussed here, as the damage it does to tumors is mostly from energetic ions produced by the secondary nuclear reaction after the neutrons in the external beam are absorbed into boron-10 (or occasionally some other nuclide), and not due primarily to the neutrons themselves. It is therefore a type of secondary particle therapy.

Muon therapy, a rare type of particle therapy not within the categories above, has occasionally been attempted.

Between May 2010 and November 2014, 110 Patients with skull base meningioma were treated with particle radiotherapy at the Heidelberg Ion Therapy Center (HIT). Primary localizations included the sphenoid wing (n = 42), petroclival region (n = 23), cavernous sinus (n = 4), sella (n = 10) and olfactory nerve (n = 4). Sixty meningiomas were benign (WHO °I); whereas 8 were high-risk (WHO °II (n = 7) and °III (n = 1)). In 42 cases histology was not examined, since no surgery was performed. Proton (n = 104) or carbon ion (n = 6) radiotherapy was applied at Heidelberg Ion Therapy Center (HIT) using raster-scanning technique for active beam delivery. Fifty one patients (46.4%) received radiotherapy due to tumor progression, 17 (15.5%) after surgical resection and 42 (38.2%) as primary treatment.

Median follow-up in this analysis was 46,8 months (95% CI 39,9-53,7; Q1-Q3 34,3-61,7). Particle radiotherapy could be performed safely without toxicity-related interruptions. No grade IV or V toxicities according to CTCAE v4.0 were observed. Particle RT offered excellent overall local control rates with 100% progression-free survival (PFS) after 36 months and 96.6% after 60 months. Median PFS was not reached due to the small number of events. Histology significantly impacted PFS with superior PFS after 5 years for low-risk tumors (96.6% vs. 75.0%, p = 0,02). Overall survival was 96.2% after 60 months and 92.0% after 72 months from therapy. Of six documented deaths, five were definitely not and the sixth probably not meningioma-related.

Particle radiotherapy is an excellent treatment option for patients with meningiomas of the skull base and can lead to long-term tumor control with minimal side effects. Other prospective studies with longer follow-up will be necessary to further confirm the role of particle radiotherapy in skull base meningioma [1].

1)

El Shafie RA, Czech M, Kessel KA, Habermehl D, Weber D, Rieken S, Bougatf N, Jäkel O, Debus J, Combs SE. Clinical outcome after particle therapy for meningiomas of the skull base: toxicity and local control in patients treated with active rasterscanning. Radiat Oncol. 2018 Mar 27;13(1):54. doi: 10.1186/s13014-018-1002-5. PubMed PMID: 29587795; PubMed Central PMCID: PMC5870393.