Stereotactic Radiosurgery

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***Abstract*—Stereotactic Radiosurgery is the use of narrow beams of radiation to perform noninvasive procedures to shrink tumors throughout the brain and body as well as assist in diminishing effects from psychological disorders.**

I. Introduction

Stereotactic radiosurgery is a very important procedure for patients with tumors in high risk locations or whom are at high risk for complications during open surgery. The process of stereotactic radiosurgery was first invented in 1950, and since then this type of noninvasive surgery has progressed throughout the years with the invention of different types of machines to more accurately perform the required surgery. All of these devices use precisely targeted radiation that is applied at different angles or arcs (depending upon the type of machine) to damage the cells of a tumor which will lead to shrinkage of the tumor. Stereotactic radiosurgery targets an extremely small area while not damaging the healthy tissue around it which leads to its superiority in depleting tumors in delicate locations. Over time it has been discovered that these machines can be used for treating functional disorders such as obsessive compulsive disorder (OCD) and deep cluster headaches by damaging the nerves that create the negative effects caused by these disorders.

II. Methods

The three different types of machines used in stereotactic radiosurgery are the cyclotron (referred to as the particle beam) which accelerators protons, the cobalt-60 which is a photon machine, and the linear accelerator also known as linac which accelerates electrons. The use of these different devices is based on the different sizes and type of disorder being treated. The cyclotron costs over 100 million dollars and treats body and brain tumors but due to the cost, little research is currently available. A popular cobalt-60 machine is known as the gamma knife which uses the radioactive isotope cobalt-60 to produce gamma rays that are pinpointed to the tumor location. The cobalt-60 machine is more effective on tumors below 3.5 cm due to its lack of movement during surgery and therefore its high precision. The linear particle accelerator is best used on larger tumors (over 3.5 cm) and is usually done over several sessions instead of a single session like the gamma knife. The linac has less precision due to the fact that it fires a single beam that moves during treatment which is why it is more effective on larger tumors. Regardless of the type of machine used, the radiation will begin to deteriorate the cells effectively shrinking the tumor over time. The rate the tumor shrinks is dependent upon the rate the tumor cells grew to begin with. For instance, a metastatic tumor will shrink at a much more rapid pace because metastatic cells grow more rapidly. Before the stereotactic radiosurgery occurs, a frame is placed around the patients head with pins to keep it in place as they undergo an MRI to properly plan for the proper distribution of radiation.

III. Results

At this current time, the majority of stereotactic radiosurgery is applied to the minimization of tumors. It takes approximately 6 months to 2 years for the degradation of the tumor to complete. The side effects are minimal and rare. Swelling in the brain is a possibility, but this can be controlled with medication and often does not occur. Rare complications consist of reddening and irritation of the skin, nausea, and seizures. The patient can actually go back to work or school the same day. Extremely rare complications such as deafness and visual loss can occur depending upon where the location of the treatment site is. Even though these complications do exist, it is still a less risky procedure than whole brain radiation therapy or exposed brain surgery.

Stereotactic radiosurgery has also been used to reduce the symptoms of OCD by creating a lesion in the anterior capsule. The anterior capsule is the environment in the brain which is linked to generating signals that cause OCD. In 2011, the use of the gamma knife on extreme OCD patients was halted due to the appearance of brain cysts in patients. Previous individuals who underwent this surgery were monitored for five years of follow ups without any development of a brain cyst. It was concluded that the cause was the newer model of the gamma knife due to the blatant success of this surgery previously. A study has also been done on the use of gamma knife surgery in deep cluster headaches in which the trigeminal nerve that causes deep cluster headaches is damaged. Unfortunately, there is still a high relapse rate and therefore more trials must be conducted to further gain knowledge in to gamma knife surgery and its effects.

IV. Discussion

Stereotactic radiosurgery is available in 100 cities all over the world. The future hope of this noninvasive surgery is that it can be applied to many types of disorders throughout the brain and body. More funding for clinical trials to purchase these machines would be essential to further the knowledge of the possible capabilities of stereotactic radiosurgery. Overall, this noninvasive procedure has been improving over the past 50 years to provide individuals with the essential care to help shrink tumors in high risk locations and will continue to do so with the improvement of technology.

References

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