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Tears: A Bizarre Cause of Collision in Gamma Knife Radiosurgery

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The gamma knife radiosurgery (GKRS) machine is a beautiful product of engineering that facilitates seamless treatment of intracranial pathologies while maintaining a high degree of precision, accuracy, and conformity. With the upgrading of the machine model from 4C to Perfexion and then ICON, the comfort and reachability have become unparalleled compared to any other treatment modality [1, 2]. Another significant improvement is the change in the shape of the collimator helmet from hemisphere to cone shape. Infrequently, a treatment plan may need to be canceled if a planned beam cannot be delivered because of a collision between the collimator helmet and the patient's skull or the frame (including the post and the screw). Whenever the distance between the frame/post/screw and the collimator helmet is less than the preset level, the gamma machine warns about the possibility of a

collision. The approved distance without a collision is >12 mm for the frame, post, and screw, and >19 mm for the patient's skull when a dedicated skull helmet for creating skull contours is used. There are specified default settings for the posts and screws, such as an anterior post height of 123 mm and a posterior post height of 85 mm, and a protruding screw length of <10 mm. An accurate frame placement with the centralization of the target is a prerequisite for avoiding the collision. Sometimes, even after the best possible frame placement, the gamma knife plan shows the inability to execute the plan. In that situation, several modifications are done such as a change in the gamma angle, placement of an additional skull frame, or replacement of the frame in a modified way to reach the target. Whenever such an event happens, it leads to trouble for the treating team and discomfort for the patient [1].

The placement of frame and screw within the desired limit further reduces the chances of any collision inside the treatment gantry. The collision is initially checked with the placement of the collimator cap, MR/DSA indicator cap before image acquisition. After the planning, the clearance map provides a rough indication for checking collisions in the gamma knife treatment planning. The clearance map is created based on the collision warnings. The coordinates of the warnings are created after the manual calculation of the post lengths below and above the horizontal base frame. Once cleared, a manual check with each questionable shot is done after docking the patient's head in the gamma knife couch. For all practical purposes, the most common cause of the collision is not the patient's head but the post or screw. Collision warnings distribute mostly at the anterior and the posterior ends of the head and less in the cranio-caudal direction.

We have faced a difficult situation while administering gamma knife treatment to a 7-year-old boy with residual resistant acromegaly. The frame was placed equidistant keeping the nose in the center thereby centralizing the sellar region (Fig. 1). All collision checks were confirmed, and no collision was reported, as the lesion

Fig. 1. a Leksell frame G mounted centrally on the patient's head. **b** Collision error repeatedly reported during the treatment.

Color version available online

was central and easily achieved with the treatment plan. Shortly after starting the treatment, the child got restless and started crying. After a while, the machine stopped the treatment indicating a collision error, but we could not find any source of contact. The child was removed from the docked position, and the treatment was restarted after consoling the child and reconfirming the treatment. Within the next 10 min, the child again started crying, and the treatment stopped indicating a collision error. This time, the machine needed a manual closure as the emergency stoppage failed to respond. The same event happened three more times when the senior resident (A.K.) realized that the child's hair was wet because of the dripping tears. While manually closing the machine, he realized drops on the floor of the gantry. The child was taken out of the treatment room, and the hair was dried with a drier. A dry cotton sponge was kept at the back of the patient's head inside the frame with the help of a bandage to avoid any liquid to drip inside the gamma gantry, and the treatment was restarted. It could be completed without any further collision. We realized that the gantry was falsely considering teardrops as a source of contact with the inside of the gamma gantry.

The cone inside the treatment area is a collision sensor suspended on sensitive springs. The sensors' function is to suspend treatment if the cone is displaced such that it creates an electrical connection with the collimator system. This shorting to the ground is the trigger to prevent a mechanical collision between the fixated patient and the collimator. The sources are withdrawn to the park position and treatment stops. Then, it is necessary to enter the treatment room and manually withdraw the patient. All of this is according to the product design, since the system believes a collision has occurred and it would be a risk to allow further remotely controlled movement of the patient. As the sources are in the park position, the radiation is effectively blocked, so personnel that en-

ter the treatment room for manual removal of the patient are at very minimal risk of any exposure. All treatment parameters are stored, and the patient's plan is picked up where it was halted and will continue when restarted from the point of termination (personal communication from the Leksell engineering team).

It seems that the patient's tears, in this case, were sufficient to trigger the collision sensor. One can wonder if the system has become overly sensitive, in which case it would be recommended to inspect and perhaps change the springs. This case highlights the extreme sensitivity of the gamma gantry to avoid any unnecessary radiation or wrong delivery of the treatment. There is no such event reported in the literature, and the treating team was perplexed by this event causing a treatment delay of more than 4 h. We are thankful to the senior resident (A.K.) whose suspicion on the teardrops as a probable cause could guide us in that stressful time when the child kept weeping, and the treating team was facing a tough situation in handling the anxious parents. The treatment of pediatric patients under general anesthesia is another solution for this possible complication.

Disclosure Statement

The authors have no conflicts of interest to declare.

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