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Simple Laterality Check for Trigeminal Neuralgia Radiosurgery: Technical Note and Aspiration for the Future

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Published 03/05/2025

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Categories: Medical Physics, Radiation Oncology
Keywords: trigeminal neuralgia

How to cite this abstract
Pannullo S, Popple R, Pantelis E, et al. (March 05, 2025) Simple Laterality Check for Trigeminal Neuralgia Radiosurgery: Technical Note and Aspiration for the Future. Cureus 17(3): a1496

Abstract

Objectives:

"To Err is Human" (Kohn et al., 2000). Errors occur in all aspects of medicine, including procedure-based specialties. One of the most dreaded and visible types of surgical or procedural errors is a left vs. right mistake, sometimes called a "laterality error" (Lee et al., 2015). These errors can occur even in highly specialized areas of medicine, such as cranial stereotactic radiosurgery, despite highly trained, certified, and regulated practitioners. Patients being treated for so-called "functional" disorders are particularly vulnerable to laterality errors, since targets typically exist in symmetrical structures, and have no morphologic anomaly that is visible on neuroimaging.

Trigeminal neuralgia is the most common functional indication for radiosurgery. Studies and clinical experiences confirm the importance of radiosurgery in treating trigeminal neuralgia (Gorgulho et al., 2006; Kondziolka et al., 1996). Laterality errors have been cited in the literature but are even more well known from open discussions of the problem.

Thalamotomy, with both cobalt-60 and linear accelerator (LINAC) based radiosurgery, has emerged as a significant and growing functional application in the treatment of medically refractory tremors. Radiosurgical thalamotomy provides a non-invasive alternative for patients who are not candidates for deep brain stimulation or other surgical interventions, with studies demonstrating significant improvements in tremor control and quality of life (Witjas et al., 2015; Niranjan et al., 1999; Martínez-Moreno et al., 2018).

When laterality errors occur, patient harm can result. Even in cases of no patient harm, the downstream effects can be devastating, including malpractice litigation, reputational damage, and psychological distress to both the patient and the radiosurgery care team. The Nuclear Regulatory Commission (NRC) has highlighted the need for robust verification processes to prevent such misadministration errors, particularly in high-risk treatments like radiosurgery (NRC, 2000).

A variety of procedural mechanisms have been developed to reduce the risk of laterality errors, including visual inspection of the planned target, labeling of the target, visual examination of computerized or paper representation of the planned target, visual confirmation of set up of the patient in the treatment machine, and use of "time out" checklists. For functional radiosurgery, one widely used technique is to validate that the planned lateral stereotactic coordinate of the patient (Tuleasca et al, 2019), matches the patient-reported side to be treated. In this study, we adapt and validate this technique for LINAC radiosurgery using the couch position after patient positioning, following International Electrotechnical Commission (IEC) 61217 coordinate convention.

Methods:

After the treating neurosurgeon and/or radiation oncologist asks the patient to point to the side of their trigeminal pain, and appropriately marks that side, the radiation therapist and/or medical physicist reviews

the lateral (IEC X) coordinate of the patient after positioning the patient for treatment on the LINAC machine.

We retrospectively obtained the lateral couch positions after patient positioning for 172 LINAC radiosurgery treatments for trigeminal neuralgia (98 right-side and 74 left side) Couch positions were evaluated relative to an assumed IEC isocenter x-coordinate of 0.0 cm.

Results:

The proposed technique demonstrated ability to detect a discrepancy between the intended, “prescribed” side and the actual anticipated position of the patient in the treatment room. The mean (standard deviation) couch position was -1.92 (0.28) and 1.59 (0.43) cm for left and right trigeminal nerves, respectively. All values for each side had the same sign: the values closest to midline were -1.34 and 0.34 cm for left and right trigeminal nerves, respectively.

This method functions as an extra “time out” or pause in the existing workflow to minimize the risk of laterality errors in functional radiosurgery. We estimate that this added step will require less than a minute. No additional equipment is required, so other than the small amount of time added, this technique has no cost and can be implemented at all centers without any capital expenditure.

Conclusion(s):

Our study validates that checking the value of the x-coordinate can add an additional safety step for isocentric LINAC-based functional radiosurgery treatments. When combined with a patient self-reported indication of which side should be treated, this simple technique can serve as an extra “time out” in the treatment workflow which can help minimize the risk of laterality errors in functional radiosurgery. We estimate that this added step will require less than a minute and no additional equipment is required. This technique supplements existing checks, such as checklists, contour review, and review of pre-procedural clinical notes to verify the intended anatomical target(s).

We encourage radiosurgery device manufacturers to consider adding another safety layer by modifying treatment planning software to require in-software verification of the intended side along with a discrepancy check against the x-coordinate. We anticipate further developments may include applications of artificial intelligence (AI) algorithms to help identify left-right discrepancies (Jang et al., 2018). A model for such a system already exists in neuroradiology, where artificial intelligence is used to flag left-right discrepancies (Hosny et al., 2018; Lyo et al., 2014). Automated mechanisms should be explored as an alternative to relying solely on fallible human oversight in laterality confirmation for functional radiosurgery.