Purpose:
To determine the appropriate margin expansion from clinical target volume (CTV) to planning target volume (PTV) for single-fraction stereotactic radiosurgery (SRS). Setting a proper margin is crucial for delivering the right dose to the CTV and sparing of organs at risk.

Methods:
Whereas in conventional fractionated treatment a Gaussian function is used to represent systemic errors, for single-fraction treatment with a specific machine, the delta function is more appropriate. As input to the function, we measured the differences between image isocenter and radiation isocenter for a Varian Trilogy linac over a period of six weeks. To approximate the residual setup errors for a population of patients, we adopted a Gaussian function with different standard deviation. A phenomenological formula for calculating the CTV-PTV margin for single-fraction SRS brain cases is proposed. For 95% success (CTV received prescribed dose) of patients' treatments, the margin for a single-fraction treatment is obtained which is a function of standard deviation of the residual setup errors and system errors.

Results:
The differences between the image isocenter and radiation isocenter remain constant to within sub-millimeter during the typical treatment period of six weeks. This confirms our assumption on the system errors distribution as being a delta function and machine-specific. This definition is especially important for a single-fraction treatment. Our study found that human factors could also attribute to the reduction of the margin of CTV-PTV in addition to stability of the treatment machine.

Conclusions:
A margin formula is proposed for the SRS brain case that attempts to help physicists determine the proper margin of CTV- PTV. This margin derivation could also extend for multi-fraction cases because the system errors do not change from time to time unless system upgrades.

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