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Optimising trajectory planning for stereotactic brain tumour biopsy using artificial intelligence: a systematic review of the literature

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Abstract

Purpose: Despite advances in technology, stereotactic brain tumour biopsy remains challenging due to the risk of injury to critical structures. Indeed, choosing the correct trajectory remains essential to patient safety. Artificial intelligence can be used to perform automated trajectory planning. We present a systematic review of automated trajectory planning algorithms for stereotactic brain tumour biopsies.

Methods: A PRISMA adherent systematic review was conducted. Databases were searched using keyword combinations of 'artificial intelligence', 'trajectory planning' and 'brain tumours'. Studies reporting applications of artificial intelligence (AI) to trajectory planning for brain tumour biopsy were included.

Results: All eight studies were in the earliest stage of the IDEAL-D development framework. Trajectory plans were compared through a variety of surrogate markers of safety, of which the minimum distance to blood vessels was the most common. Five studies compared manual to automated planning strategies and favoured automation in all cases. However, this comes with a significant risk of bias.

Conclusions: This systematic review reveals the need for IDEAL-D Stage 1 research into automated trajectory planning for brain tumour biopsy. Future studies should establish the congruence between expected risk of algorithms and the ground truth through comparisons to real world outcomes.

Keywords: Trajectory planning; artificial intelligence; biopsy; brain tumour; neurosurgery; stereotactic.