Australian Brain Alliance

CRACK THE BRAIN'S CODE

TRACTOGRAPHY: SAFER BRAIN SURGERY

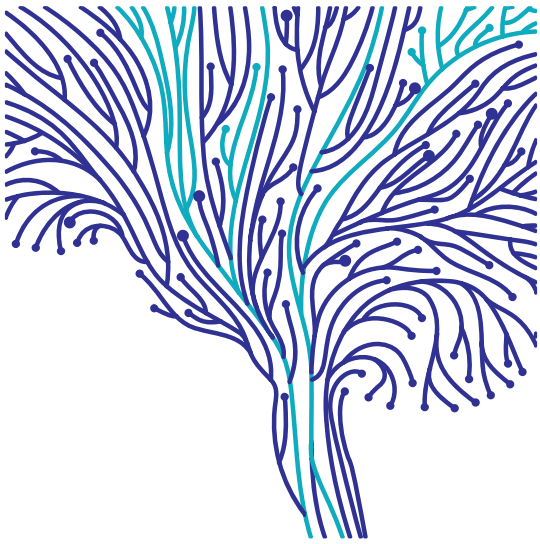
What is tractography?

Magnetic resonance imaging (MRI) techniques are used to help plan neurosurgery procedures. Scientists construct a 3D map of the patient's brain, identifying healthy brain regions, and the locations of arteries, veins and important brain nerve fibre tracts and then overlay this map on a live image of the patient's brain during surgery.

Damage to these brain regions during surgery can lead to irreparable damage, so having the most precise and accurate picture as possible is paramount.

Tractography focuses on identifying the brain nerve fibre tracts, also known as white matter tracts. These transmit important information that controls motor, language, vision and other brain function.

Accurate tractography imaging helps protect vital nerve pathways, including those for vision, language and motor function.



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The commercially available tools for mapping the white matter tracts use deterministic, tensor-based tractography, a technique that was developed more than 15 years ago. This method's primary advantage is speed, which means it can be used as an interactive tool during surgery. Its downside is its inability to accurately model crossing nerve fibre arrangements which are present in up to 90 % of the brain white matter regions. This means surgeons are unable to accurately map the size and shape of the white matter tracts. Damage to these during surgery can have detrimental consequences. There is increasing agreement among neurosurgeons that there is a need to move beyond deterministic tensor-base tractography.

Recent research has led to a more advanced modelling and image reconstruction technique—a constrained spherical deconvolution modelling and a probabilistic tractography technique—to produce better models and displays of crossing fibres. The probabilistic tractography technique allows for a degree of randomness and variation and is a vast improvement on the previous deterministic model.

Australian researchers have developed an open-source software tool, MRtrix3, which offers a processing platform for improved tractography modelling and display of crossing fibres. This software improves white matter tract imaging, and it can also be applied to other imaging data to improve outcomes for other types of surgery. MRtrix3 has already been used at the Royal Children's Hospital in Melbourne to improve surgical outcomes for children with epilepsy or brain tumours.

The Australian Brain Initiative will nurture the basic brain research required to better understand the underlying brain structure. The Initiative will also facilitate the application of laboratory basic research techniques in a clinical setting—taking developments from bench to bedside—advancing and refining the techniques that will make neurosurgery of the future even safer and more effective.

Surgeons need accurate and detailed brain maps to perform safe and effective surgery.

Up to 90% of brain white matter regions can contain complex nerve fibre arrangements—these are difficult to model and display accurately.