Improving Surgical Outcomes
Using Functional Magnetic Resonance Imaging in Brain Surgeries

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Introduction

- Functional Magnetic Resonance Imaging (fMRI) is crucial in improving brain surgeries by providing detailed images of brain activity.
- fMRI identifies areas of importance such as speech and movement, so the surgeon knows the areas to avoid during surgery.
- It is noninvasive and painless with very little to no risks.
- During fMRI the patient wears goggles and performs basic tasks while the brain activity is recorded.
- A standard MRI does not involve goggles or basic tasks and does not take as long as a functional MRI.

MRI vs fMRI

- MRI uses powerful magnets and radio waves to produce detailed images of internal body structures.
- Because MRI does not use radiation, it is generally safe for most people.
- Surgeons may use MRI along with special software to locate and target specific brain regions for non-invasive procedures.
- fMRI expands on MRI by measuring changes in blood flow and oxygen levels in the brain, detecting which areas of the brain become more active during certain tasks.
- fMRI assists doctors in seeing how different brain regions work together and communicate
- fMRI can also be paired with non-invasive brain stimulation to study how changing brain activity affects different regions.

What is fMRI measuring?

- fMRI tracks brain activity by measuring changes in blood oxygen levels.
- When neurons become more active, they use more oxygen, so the body sends extra blood to that brain region.
- Hemoglobin, the molecule that carries oxygen, has different magnetic properties depending on whether it is oxygen rich or oxygen poor.
- fMRI picks up on these magnetic differences called BOLD signals (Blood Oxygen Level Dependent).
- First, there is a small dip in the BOLD signal because oxygen is being used up.
- This is quickly followed by a larger rise in oxygenated blood flow to the active brain area.
- By detecting these changes fMRI produces detailed maps showing which brain areas are active during certain tasks or functions.

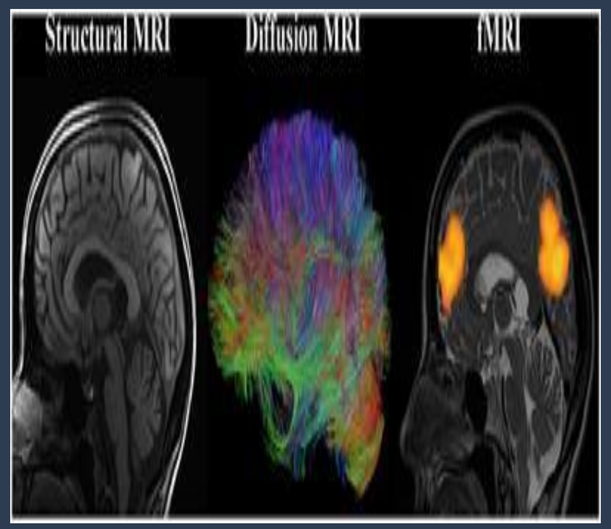

Figure 1: Different Types of MRI Scans

What is fMRI used for?

- fMRI maps brain activity by linking blood flow with brain function.
- This helps doctors identify critical brain areas to avoid during surgery, lowering the risk of damaging important functions.
- New technology has improved fMRI accuracy through sharper imaging and advanced algorithms that interpret results more precisely.
- These improvements allow for personalized surgical planning based on each patients unique brain structure and function.
- In epilepsy cases resistant to medication, fMRI helps locate seizure-causing regions to guide surgery.
- For brain tumor surgeries, fMRI shows which areas control vital functions so surgeons can avoid harming them.
- Overall, fMRI integration in neurosurgery makes procedures safer and extremely more effective.

Figure 2: MRI Machine

Conclusion

- fMRI has transformed neurosurgery by giving detailed, dynamic images of brain activity.
- It helps surgeons identify and protect critical areas that control movement, speech, and sensory functions.
- fMRI works by measuring blood flow and oxygen changes to map active brain regions.
- It distinguishes between oxygen rich and oxygen poor hemoglobin to create live maps of brain activity.
- It is non-invasive, painless, and safe for most.
- This makes fMRI essential for pre-surgical planning, reducing risks during brain surgeries.
- As technology improves fMRI promises even better surgical outcomes and quality of life for patients.
- Beyond surgery it even deepens knowledge of the brain, making progress in neuroscience and treatments.

References

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