The Role of Intraoperative MRI (ioMRI) in influencing the Outcomes of Resective Epilepsy Surgery – An Initial Experience

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Changing times..Changing Technology...Changing Practices?

• Resective surgery has for many years proved its value in epilepsy.

• Image guidance during surgery has been in vogue for over a decade and is commonplace in tumour surgery.
Problem statement: (How is it different?)

- Most epilepsy surgery involves ‘disconnection,’ standard anatomical landmarks should therefore suffice.
- In epilepsy surgery, ‘success’ is purely based on the outcome (i.e., freedom from seizures).
- One of the important components of success in tumour surgery is “completeness of resection”.

Problem statement: (How is it different?)

- Differences in surgical goals and outcome measurements between epilepsy and tumour surgery.
- Does ioMRI influence the outcomes of epilepsy surgery for the better?
Objectives:

- To study if the use of ioMRI has influenced the outcomes of epilepsy surgery.
Materials & methods: (Study design)

- Retrospective data analyses of cases operated at Alder Hey for pharmacologically refractory epilepsy (PRE).

- VNS cases were excluded as ioMRI is not used.
Materials & methods: (Study design)

• Patients for whom a period of >12 months had elapsed since the surgery were included.

• This was done with the view that the outcome in the first 12 months might not reflect the true long-term outcome due to confounding factors like anti-epileptic dose adjustments and rehabilitation.
The patients were asked to fill in an “Impact on the Quality of Life Questionnaire”.

This had 7 questions with a response being graded on a scale from 0 to 5 in ascending order of improvement.

- 0 - No improvement
- 1 - Minimal/insignificant improvement
- 2 - Some improvement but no impact on overall scenario
- 3 - Improvement present (<50%) but a definite beneficial effect
- 4 - Considerable improvement with considerable benefit
- 5 - Normalisation/alleviation of symptoms
- NR - No response/Unable to quantify
Impact on the Quality of Life Questionnaire:

Parameters measured:-

1) Seizure outcome after surgery.
2) Alertness
3) Social interaction
4) Memory & cognition
5) Mood and behaviour
6) Sleep patterns
7) The quality of life of the caregiver

The last question is often forgotten but is of equal importance in quantifying benefit.


• This is different from the Engel or ILAE outcome scores which were predominantly seizure oriented
Results:

• Period of study: 2009-2015 (6yrs)

• Number of patients: 65 (72 pathologies)

• Age range (yrs): 2-18yrs. Median age 9.7yrs.

• Follow-up period: 13 months to 6yrs
Pathology:

- Spectrum of pathologies. Some had >1 pathology.
- 72 different pathologies from 65 patients.
- 23 were ‘Lesionectomies’ (SOL).
- 49 were ‘disconnections’. Hypothalamic hamartomas were included here as the emphasis is on disconnection.
Pathology

Distribution of pathology

- SOL-Lesionectomies: 23
- Non-SOL: 49
Pathologies:

- SOL (n=23)
  - DNET
  - SEGCA
  - Cavernoma
  - Ganglioglioma
  - Fibrillary astrocytoma
  - Angiocentric glioma
  - Oligodendrogioma G2
  - Rec.Oligodendrogioma G3
  - Gliosis
Pathologies:

Non-SOL pathologies (n=49)

- HME
- Tubers
- Encephalitis
- Hippocampal sclerosis
- Cortical dysplasia
- MTS
- FCD Ia
- FCD Ic
- FCD IIa
- FCD IIb
- FCD IIIa
- FCD IIIid
- FCD III (NOS)
- HT hamartomas
- Neuronal Heterotopia +CD
- MTS + FCD
- Tuber + FCD
Results (Analysis of ioMRI data):

**Actions after ioMRI**

- **Closure**: 44
- **Further resection & closure**: 13
- **Resection, rpt IOMRI & closure**: 6
- **Closure & post-op MRI**: 1
- **No IOMRI**: 1
Results: (Analysis of ioMRI data)

Cases who underwent a further resection following ioMRI (n=19) (29.2%).

Procedure type correlated with action after ioMRI

- Closure-SOL 'Lesionectomy'
- Closure-Disconnection
- Further resection
- No IOMRI
Results:

Two subsets of patients were identified:-

- ioMRI followed by closure (representing disconnections)
- ioMRI was followed by further resection (with/without repeat MRI) & closure. (representing lesionectomies).

Pitfalls in the study design:

- The ideal study would have been to compare outcomes of disconnective procedures and lesionectomies as discrete sets prior to and after the advent of the ioMRI. But such data was unavailable.
- So the above method was employed so that disconnection and lesionectomies could be compared though this comparison wouldn’t be accurate.
- Nevertheless it could shed some light on certain trends in long term outcomes.
- A prospective study correlating the use of ioMRI, procedure type and correlation with Engel or ILAE outcomes would be ideal.
Results:

- ioMRI aided in the completeness of excision in tumours & cavernomas.

- In ‘disconnections’ too, ioMRI did show modestly better outcome scores.

- *Quality of life questionnaire* data was analysed. The response rate of the patients thus far has been 72% (complete questionnaires).
Results:

• Those who responded with a 4 or 5 for the questions were taken as good outcomes.

• The most significant ‘good outcomes’ overall were in the domains of seizure frequency (74.4%), alertness (56.8%), interaction with the environment (50%) and quality of life of the caregiver (62.9%).

• The domains comprising memory, mood and sleep showed an equivocal distribution of scores.
Results:
The scores obtained for the Quality of life questionnaire:

- Seizures
- Alertness
- Interaction with environment
- Cognition and memory
- Mood
- Sleep
- Caregiver's quality of life

Scores:
- 0
- 1
- 2
- 3
- 4
- 5
- No response
Results: (Outcome analysis)

4 or 5 were considered good outcomes, 3 was equivocal, 0-2 score was poor outcome

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<th>Poor outcomes</th>
<th>Equivocal</th>
<th>Good outcome (4 or 5)</th>
<th>No response</th>
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</table>
Results: (Outcome analysis)

• Of the 19 patients who underwent further resection 18 (94.7%) had good outcome scores in all parameters. *(It must be remembered that patients with lesions generally have a better neurological level of function).* 1 patient had equivocal scores for sleep and mood.

• Of the 44 who underwent closure: 4 were SOL and the remaining were ‘disconnection procedures’-ATL/CC etc. Even in this group 29 patients (65.9%) reported a good outcome with regards to seizure frequency, interaction with environment and caregiver’s quality of life. There was a better outcome of sleep in this group 19/44 (43.2%).
Results: (Questionnaire scores in the patient subsets based on action taken after IOMRI)

Further Resection (n=19)
- Good outcome: 18
- Equivocal: 1

Primary closure (n=44)
- Good outcome: 14
- Equivocal: 2
- Poor outcome: 29
Review of literature:

Literature about experience with ioMRI in epilepsy surgery is sparse. To quote a few:-

Review of literature

2. “Impact of IOMRI on outcomes in epilepsy surgery: Preliminary experience of two years.”

“IOMRI increases the extent of resection mainly in lesional epilepsy surgeries translating into good seizure outcomes but not found to be beneficial in prototype mesial temporal sclerosis surgeries and disconnection surgeries.”
CONCLUSION:

- Intra-operative MRI is a valuable tool in epilepsy surgery.
- It gives a clear and immediate picture of the anatomical completeness of resection/disconnection.
- It helps in surgeon satisfaction.
- Useful as a form of objective documentation of the achievement of the anatomical goals of the surgical procedure.
CONCLUSION

• It allows the surgeon to speak to the family with confidence at the end of the procedure with regard to the completeness of the surgery which greatly enhances parental satisfaction.

• The emphasis in epilepsy surgery is on functional outcome.

• Preliminary data analysis does indeed suggest a trend towards better long term outcomes in epilepsy surgery with the aid of the ioMRI.
Conclusion - **Take home points:**

- **ioMRI** enabled a safer & anatomically more complete surgical resection.

- It has proven to be a valuable adjunct in ‘lesionectomies’.

- Our experience with the role of ioMRI in paediatric epilepsy surgery is relatively limited at present. More studies are needed.