The Functional Outcomes of Hemispheric Surgery at Queensland Children's Hospital

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Hemispheric Epilepsy Surgery

Selected cases of medically-refractory epilepsy (unilateral and hemispheric)

Removes or disconnects an abnormal hemisphere of the brain

1. Alleviate seizures
2. Alleviate damaging effects of seizures on development and cognition[1]

Congenital	Acquired	Progressive
Malformations of cortical development Sturge-Weber syndrome	Perinatal ischaemic stroke	Rasmussen's encephalitis

Hemispheric Epilepsy Surgery

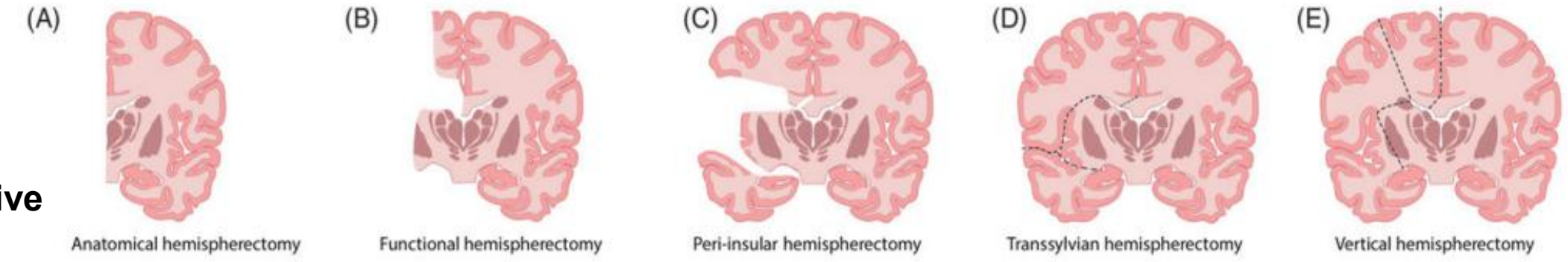
Anatomical hemispherectomy (1920's) – complete resection of abnormal hemisphere

Functional hemispherectomy (1980's) – temporal lobectomy, disconnect rest of cerebrum

Hemispherotomy focuses on tissue disconnection, rather than removal

Over time, trend towards less tissue removal to reduce complications[2]

More invasive



Less invasive

Figure: Main Surgical Techniques in Hemispheric Surgery[2]

Decision to Proceed

The decision is complex

- Risk seizure activity affecting the integrity of the normal hemisphere
- Damaging effects of seizures on development and cognition[1]

- Risk of surgical complications
- Risk losing residual critical function of the abnormal hemisphere
- Expected post-operative impairments of hemiparesis and homonymous hemianopia post-operatively[8]

Seizure freedom is a key factor that influences functional outcome (similar rates for each surgical approach [52-90%])[3-7]

Decision to Proceed

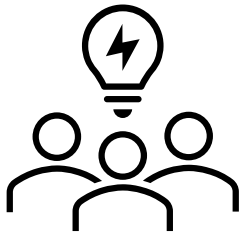
Counselling parents on the expected benefits and risks

Extensive workup performed to ascertain if diseased brain hemisphere has residual function

- MRI, video EEG +/- functional MRI, tractography, PET or neuropsychological testing[9]

At Queensland Children's Hospital (QCH): Epilepsy Case Conference

- Neurology, neurosurgery, radiology, nuclear medicine, neuropsychology



Impairment ≠ Ability to Function

1. Expected post-operative impairments of hemiparesis and homonymous hemianopia are frequently present pre-operatively (given the nature of underlying disease)
2. Increase in impairment is typically considered an acceptable trade-off to mitigating the detrimental effects of refractory seizures on the child's ongoing development[8, 10]
3. Children are capable of **improved function and skill development** despite these expected impairments[8]

Surgical Outcomes at QCH

Yates et al. reviewed **surgical** outcomes of 13 patients who underwent a specific hemispheric surgery (peri-insular hemispherotomy)

Key findings (mean follow up period of 1.7 years)

- Seizure freedom in 84.6% patients
- Anti-epileptic medications ceased in 53.8% patients
- Hemiparesis worsened in 76.9% patients
- Hemianopia due to the surgery itself in 15% patients
- Complications in 38.5%: hydrocephalus requiring VP shunt, subdural hygroma, SIADH, residual connection

Functional outcomes were not explored…

and had not been explored at QCH until now

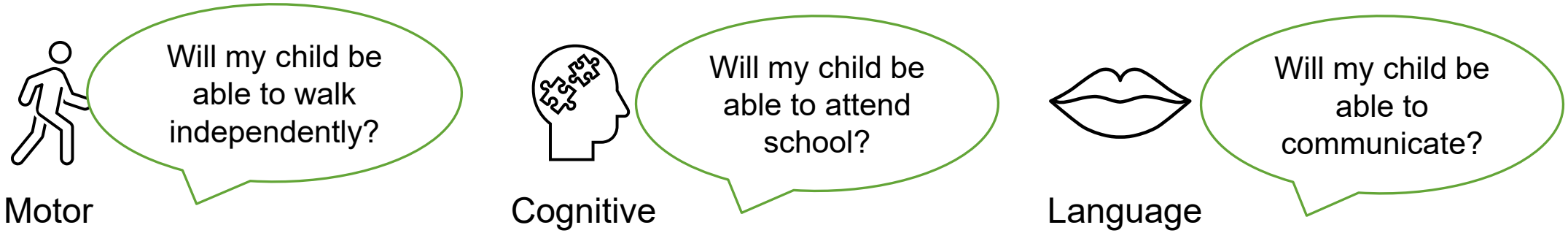
Functional Outcomes

Ability to function **cannot** be defined by post-operative neurological impairments

It is important that functional outcomes are understood

1. To provide realistic pre-operative counselling to families
2. To guide rehabilitation goals

Patient and family-centred care is important



Functional Outcomes

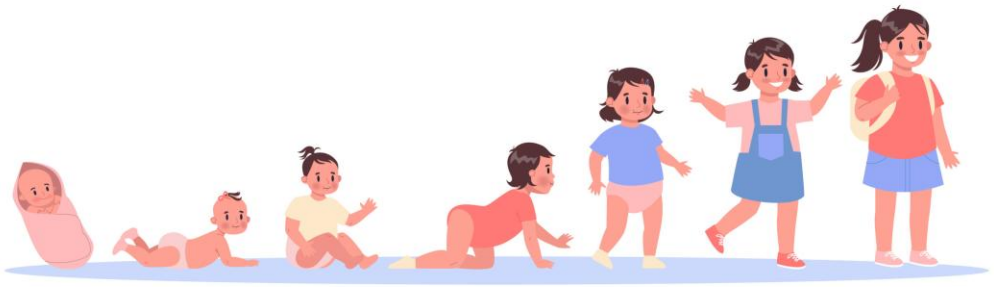
Studies are often limited by small sample sizes and subjective, heterogeneous, retrospective data[11]

No standardised protocol for functional assessment locally or worldwide

Streamlining assessments in this cohort is difficult because:

- Epilepsy severity limits feasibility of conducting comprehensive evaluations
- Complex medical profiles can preclude participation in assessments, e.g., comorbid language and cognitive deficits[8]

Functional priorities shift with age and different measures are validated for different age groups



Functional Outcomes – What is Known?

Overall, studies have found motor, cognitive and language function remains **stable** post-operatively

Motor

83-89% ambulate independently before surgery, and continue to do so post-operatively[1, 8, 12]

Cognitive

Most studies demonstrate stable cognitive function post-operatively [6, 8, 13, 14]

Language

Post-operative worsening of language function is rarely seen[10]

Our Study

A retrospective review of the functional outcomes of hemispheric surgery for medically refractory epilepsy at Queensland Children's Hospital from 2014 to 2022

1. Enable comparison of local outcomes with the literature
2. Potentially identify areas of standardisation in the approach to functional assessment
3. Improve pre-operative counselling and post-operative rehabilitation for this cohort

Audit of records at **baseline** and **over a two-year follow up** period

Eligibility

- Birth to 18 years old at time of surgery
- Surgery occurred from 2014 to 2022
- Followed up at Queensland Children's Hospital post-operatively

Data Collection

Demographics

Epilepsy burden

Surgical and post-operative admission details

Neurological impairments

Functional assessment outcomes…

- WeeFIM
- Functional Mobility Scale
- Independent ambulation
- CFCS
- PediCAT
- MACS
- Full-scale IQ
- Clinical Evaluation of Language Fundamentals (CELF)
- GMFCS
- Assisting Hand Assessment
- Adaptive Behaviour Assessment System (ABAS)

Data analysis focused on comparable pre- and post-operative results

Patient Cohort

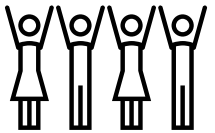
Twenty-two patients included

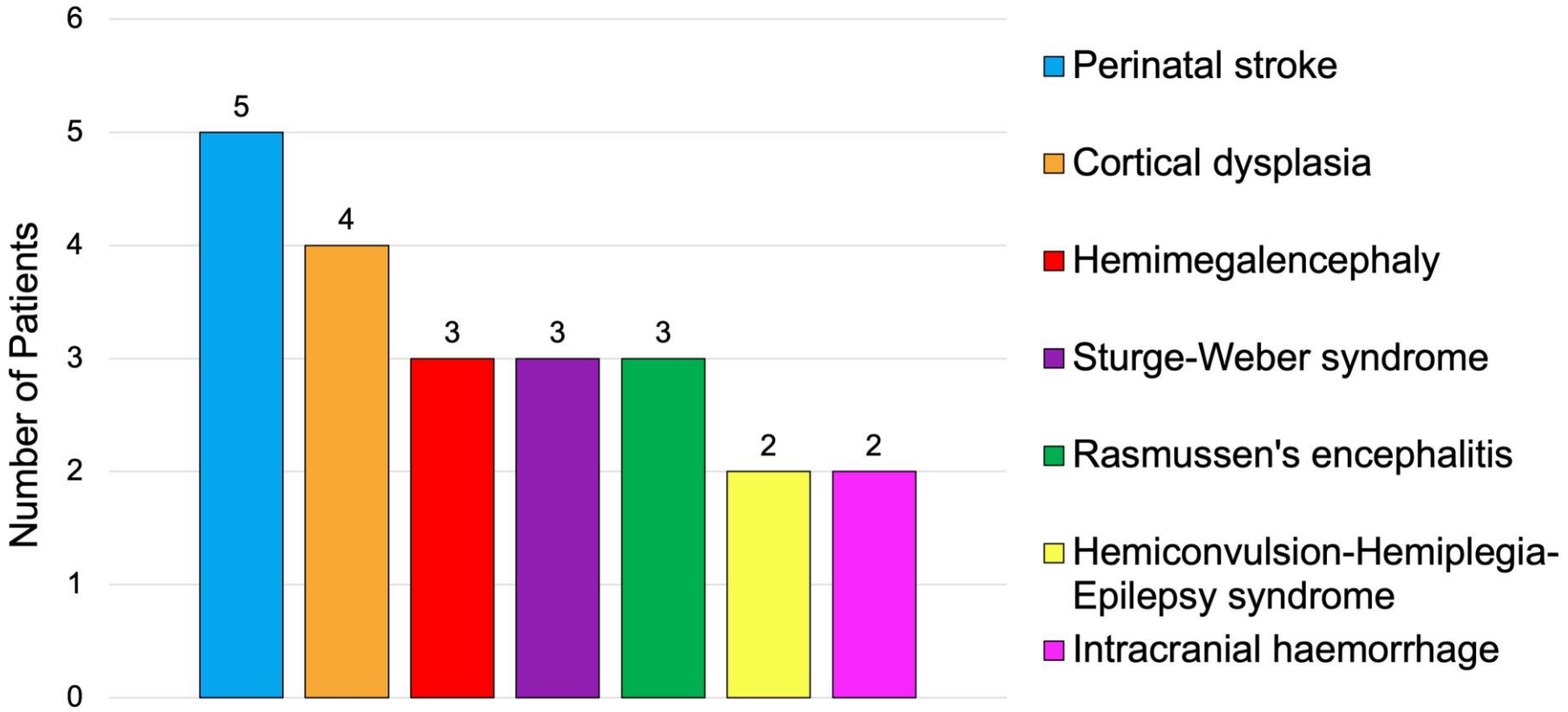
Nine females (40.9%), thirteen males (59.1%)

Thirteen patients (59.1%) developed epilepsy before six months of age

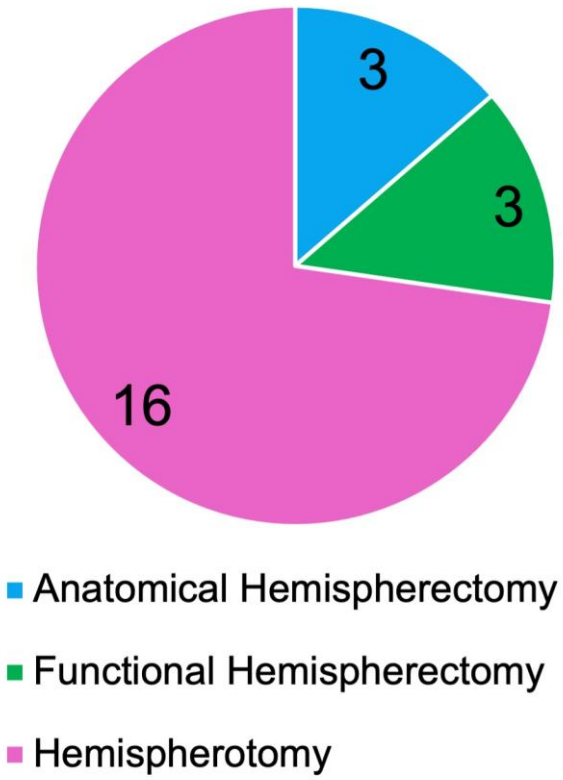
Only three patients (13.6%) developed epilepsy over the age of 5 years

Aetiology




Number of Patients
0
1
2
3
4
5
6
5
4
3
3
3
2
2
Perinatal stroke
Cortical dysplasia
Hemimegalencephaly
Sturge-Weber syndrome
Rasmussen's encephalitis
Hemiconvulsion-Hemiplegia-Epilepsy syndrome
Intracranial haemorrhage

Surgical Details



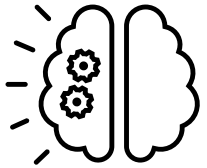
Average age at surgery 5 years (1.2 months – 13.7 years)

Hemispherotomy performed in 72.7% patients

Average acute admission 15.1 days

15 patients (68.1%) underwent inpatient rehabilitation, LOS 23.1 days

Seizure Freedom



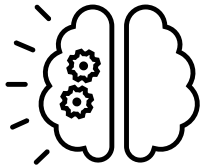
Twenty patients (90.9%) experienced complete seizure freedom (Engel Class 1)

Two had Engel Class 3 and 4 outcomes, both requiring surgery for residual connection

Anti-epileptic medication ceased for seventeen patients (77.3%) by 18 months post-op (pre-operative average 3.4 per patient)

Eighteen patients (81.8%) required no hospital admissions for epilepsy during the follow up period (pre-operative average 1.7 per patient in preceding 12 months)

Neurological Impairment



All twenty-two patients (100%) had a documented hemiparesis and visual field defect post-operatively (90.9% and 54.5% pre-operatively)

The severity of these impairments was not explored in this study

Gross and Fine Motor Function

All 13 patients who ambulated independently pre-operatively, continued after surgery.

One patient gained ambulation during the follow up period (not accounted for by their age).

11 patients had a comparable Gross Motor Function Classification Score (GMFCS) documented

- Five patients (45.4%) worsened from GMFCS I to GMFCS II
- Four patients (27.2%) remained stable
- Two patients (18.2%) improved (from one GMFCS II to I, and another from GMFCS V to IV)

Five patients had a comparable Functional Mobility Scale (FMS) documented

- One patient exhibited a worsened FMS, two exhibited no change, and two improved

Four patients had a comparable Manual Ability Classification Score (MACS) documented

- All exhibited no change in their score

Cognitive and Adaptive Function

Six patients had a comparable full-scale IQ (FSIQ) documented

- Standardised against age-based norms
- Average pre-op 61.5 (SD 11.13), and post-op 61.33 (SD 9.61)
- No significant difference in scores pre- and post-operatively (p=0.953)

Given that the cohort aged between FSIQ measurements, results may demonstrate role of surgery in limiting adverse effects of seizures on cognition.

Four patients had a comparable Adaptive Behaviour Assessment System (ABAS) score documented (Parent General Adaptive Composite (GAC))

- Median score pre-op 76.5 (IQR 5.25), and post-op 77 (IQR 4.75)
- No significant difference in scores pre- and post-operatively (p=0.625)

Conclusion and Limitations

Functional outcomes of hemispheric surgery at QCH were consistent with previous literature findings that motor and cognitive function remains stable post-operatively

Limitations

- Small sample size and retrospective data
- Nine patients had a baseline language assessment, and none had a comparable post-operative assessment performed.
- Fine patients had a baseline Assisting Hand Assessment (AHA), but none had a comparable post-operative assessment performed.
- Lack of comparable pre- and post-operative measures limits generalisability for pre-operative counselling and post-operative rehabilitation
- Use of outcome measures validated only in cerebral palsy (e.g., GMFCS, MACS, FMS) raises questions of the reliability of some results[16-18]

Future Directions

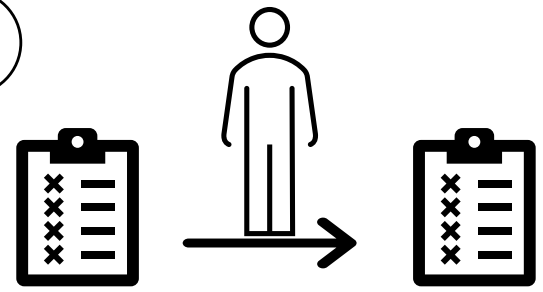
A standardised assessment protocol may improve data collection in this area, but would require flexibility to account for the challenges in obtaining outcome measures in this cohort

- Average baseline FSIQ 61.5 (SD 11.13) in the ‘extremely low’ range
- 68.2% of cohort were experiencing multiple seizures per day before surgery

Assessments need to be able to capture small differences in medically complex individuals

Validation of measures appropriate for use in paediatric hemispheric surgery would also be helpful

1



2

PEDI-CAT

Pediatric Evaluation of Disability Inventory Computer Adaptive Test

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