The Changing Surgical Landscape in Kids

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Disclosure

none
Learning Objectives

• To appreciate two fundamental changes that have led to the expanding surgical landscape in children with epilepsy
The Changing Surgical Landscape in Kids

Hypothesis

- The landscape is expanding

- This is based on two fundamental changes:
  - a change in our understanding of the risk-benefit profile of pediatric epilepsy surgery
  - a change in our overall approach to the evaluation and treatment of children with epilepsy
Hypothesis

• In contrast to adult epilepsy surgery, the change in surgical landscape in kids does not appear to be epidemiological but, rather, likely reflects a change in us and how we look at the problem
The Established Landscape in Kids

- cortical dysplasia (5)
- epilepsy-associated tumor (3, 6)
- cavernoma (4)
- hemispheric pathology (8)
- MTS (7)
- temporal/frontal resections (1)
- 20-35% intracranial electrodes (1)
- unifocal, older age (1)

Harvey S et al, Epilepsia 2008 (1); Cossu M et al Epilepsia 2008 (2); Southwell DG et al, Neurosurgery 2012 (3); Baumann CR et al Epilepsia 2007 (4); Palmini A et al Ann Neurol 1995 (5); Thorn M et al, Brain Pathology 2012 (6); Smyth MD et al J Neurosurg 2007 (7), Moosa AN et al Neurology 80:253-60, 2013 (8)
Pediatric Epilepsy Surgery
Novel Concept
The Changing Surgical Landscape in Kids--the default presumption is one of reluctance-as it should be

- Dangerous-especially in young children
- Too invasive
- Not better than medical therapy
- Costs too much
“pediatric epilepsy surgery”
PubMed search

• pre-1993 (first in 1949) n=97

• 1993-2003 n=387

• 2003-2013 n=901
My practice the last 12 months

• 78 craniotomies for children with epilepsy

• Cortical dysplasia (38%), Tuberous Sclerosis (30%), Lennox Gastaut (6%), MRI negative (6%), Sturge Weber (6%), brain tumor (5%), cavernoma (3%), porencephalic cyst (3%), encephalitis (3%)

• no mesial temporal sclerosis only
A change in our understanding of the risk-benefit profile of pediatric epilepsy surgery

In general, weighing the risk of the current course vs. the risk of surgery

- uncontrolled epilepsy is bad for the developing brain, quality of life, life expectancy
- effective epilepsy surgery in kids can improve development, quality of life
- surgery in kids is safe - comparable to other aspects of pediatric neurosurgery
- effective epilepsy surgery can be cost effective in kids
Uncontrolled epilepsy is bad for the developing brain, quality of life, life expectancy

• “Uncontrolled seizures impair cognitive function with effects being most severe in infancy and lessening with increasing age at onset. These findings further emphasize the need for early aggressive treatment and seizure control in infants and young children.” Berg AT et al Neurology 79:1384-91, 2012

• “Relative to the population...sudden and seizure related deaths alone double overall mortality...mortality is significantly higher compared with the general population in children with complicated epilepsy...the SUDEP rate was similar to or higher than sudden infant death syndrome rates.” Berg AT et al Pediatrics 132:124-31, 2013
Effective epilepsy surgery in kids can improve development, quality of life

- “After surgery, seizure frequency and developmental quotient improved.”

- “Developmental status before surgery predicted developmental function after surgery.”

- “Patients who were operated on at younger age and with epileptic spasms showed the largest increase in developmental quotient after surgery.”

Surgery in kids is safe - comparable to other aspects of pediatric neurosurgery

• “...carefully selected pediatric patients with intractable epilepsy can benefit from subdural invasive monitoring procedures that entail definite but acceptable risks” Onal C et al J Neurosurg 98:1017-26, 2003

• “There were no surgical complications related to intracranial EEG monitoring...The supplemental depth electrodes conferred an extra dimension of depth to the analysis, which allowed for successful outcome...” Kim H et al J Neurosurg Pediatr 8:49-56, 2011

• “Placement of subdural grid and strip electrodes...is generally well tolerated in the pediatric population...not associated with higher rates of...complications” Johnston JM Jr et al J Neurosurg 105:343-7, 2006
Safety

- Roth J, Carlson C, Devinsky O, Harter DH, MacAllister WS, Weiner HL

**Safety of Staged Epilepsy Surgery in Children**

- Neurosurgery (in press)
- 161 children (Mean age 7 yo, 8 mos-16 yo), 200 admissions, 496 surgeries
- No mortality
- Neuro deficit 2%, infection 1.5%, bleed 0.5%

- **Learning curve**: complications down in second half of study (1\textsuperscript{st} v. 2\textsuperscript{nd} 6 yrs, 100 admissions)
Safety

the importance of pediatric “team”, system, and no egos

- Nursing
- Neurosurgery
- Neurology
- Anesthesia
- Radiology
- Pediatrics/PICU
- Psychology/Neuropsychology/Psychiatry
- Social work
- Child Life
- Conference
Effective epilepsy surgery can be cost effective in kids

- “Surgical treatment resulted in greater reduction in seizure frequency compared to medical therapy and was a cost-effective treatment option in children with intractable epilepsy.”  
  **Widjaja E et al Epilepsy Research 94:61-68, 2011**

- Cleveland Clinic, Neurologic Institute, 2011 Outcomes
A change in our overall approach to the evaluation and treatment of children with epilepsy

In general, kids who previously would not have been candidates for surgery are being considered

- Improved diagnostic evaluations pre-operatively (MRI, PET, MEG, SPECT, fMRI)
- More comfort with invasive EEG monitoring in kids in challenging cases
- More willingness to consider aggressive surgical resections even in the face of anticipated neurologic deficits
“Epilepsy surgery may be successful for selected children... with a congenital or early-acquired brain lesion, despite abundant generalized or bilateral epileptiform discharges on EEG. The diffuse EEG expression may be due to an interaction between the early lesion and the developing brain”

“This approach can help to identify both primary and secondary epileptogenic zones in young TSC patients with multiple tubers. Multiple or bilateral seizure foci are not necessarily a contraindication to surgery.”

*Pediatrics 117:1494-502, 2006*
Improved diagnostic evaluations pre-operatively (MRI, PET, MEG, SPECT, fMRI)

The ability of high field strength 7-T magnetic resonance imaging to reveal previously uncharacterized brain lesions in patients with tuberous sclerosis complex.
More comfort with invasive EEG monitoring in kids in challenging cases

1) **Non-concordant** or **non-localizing** non-invasive studies (implies that complicated cases may still have resectable seizure focus)

2) **Normal MRI** in setting of refractory partial epilepsy (define resection)

3) Presumed seizure focus overlaps **eloquent cortex** (define resection)

4) Multiple potential (**multifocal**) seizure foci with non-localizing non-invasive studies (which one ?)

5) Structural **lesion** on MRI (define relationship of seizure focus to MRI lesion)
More willingness to consider aggressive surgical resections even in the face of anticipated neurologic deficits

- Would you agree with resecting a seizure focus in eloquent cortex (motor, visual) if you were confident it could render child seizure free?

- Painful decision with parents
- QOL intervention--Trade off of potential physical deficit for seizure freedom and developmental improvement
- Unique to pediatric medicine
Do tubers contain function? Resection of epileptogenic foci in perioroliedic cortex in children with tuberous sclerosis complex

*Yaron A. Moshel, *Robert Elliott, †Federica Teutonico, *Jonathan Sellin, ‡Chad Carlson, §§Orrin Devinsky, and ¶Howard L. Weiner

Neurosurgical management of intractable rolandic epilepsy in children: role of resection in eloquent cortex

Mony Benifla, M.D.,¹ Francesco Sala, M.D.,² John Jane Jr., M.D.,⁵ Hiroshi Otsubo, M.D.,² Ayako Ochi, M.D.,³ James Drake, M.D.,¹ Shelly Weiss, M.D.,¹ Elizabeth Donner, M.D.,² Ayatake Fujimoto, M.D.,¹ Stephanie Holowka, M.R.T.,⁴ Elysa Widjaja, M.D.,⁴ O. Carter Snejad III, M.D.,² Mary Lou Smith, Ph.D.,³ Mandeep S. Tamber, M.D.,¹ and James T. Rutka, M.D., Ph.D.¹

Speculation about future

• Will numbers go down?
• Are local community neurologists more willing to refer young patients for presurgical evaluations earlier?
• Will long term benefits outweigh natural history?
• Minimally invasive approaches (diagnostic and therapeutic)
Long-term seizure outcome after resective surgery in patients evaluated with intracranial electrodes

Juan C. Bulacio, Lara Jehi, Chong Wong, Jorge Gonzalez-Martinez, Prakash Kotagal, Dileep Nair, Imad Najm, and William Bingaman

Figure 2.
Kaplan-Meier plot illustrating chances of postoperative seizure freedom following resective surgery in all patients evaluated with intracranial electrodes following invasive evaluation. Epilepsia © ILAE

Conclusion

Long-term seizure control in the most challenging focal epilepsies can be achieved following an invasive evaluation in carefully selected patients, especially those with tumors, and with suspected temporal and parietooccipital epilepsies. On the other hand, patients with nonspecific pathologies and those who undergo sublobar resections do not do as well, even after undergoing more than one surgical resection. This suggests that these patients may harbor more diffuse epileptic/proepileptic pathologies, and therefore additional surgeries following the failure of the first one should be very carefully considered. The early postresection failure may be the result of an incomplete resection of the epileptic focus, and the later recurrences may be due to yet unknown mechanisms including the presence of more extensive but dormant pro-epileptic cortex.
Conclusion

• In contrast to adult epilepsy surgery, the change in surgical landscape in kids does not appear to be epidemiological but, rather, likely reflects a change in us and how we look at the problem
Impact on Clinical Care and Practice

• a change in our understanding of the risk-benefit profile of pediatric epilepsy surgery

• a change in our overall approach to the evaluation and treatment of children with epilepsy