Difficult topics in epilepsy surgery: insulo(-opercular) epilepsy

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Disclosure statement

• I have recently participated in a clinical trial by Sunovion/Upsher-Smith
Outline

– Anatomy, connectivity, functions
– Clinical diagnosis (a challenge)
– Non-invasive diagnosis (a challenge)
– Invasive diagnosis (a challenge)
– Surgical treatment (a challenge)
Basic anatomy

Structural connectivity

Connectivity: A-P gradient

Ghaziri J., Tucholka A., Houde J-C., Girard G., Descoteaux M., Rainville P., Nguyen DK. The subcortical structural connectivity of the human insula (submitted)
Functions

Video-EEG

VISCEROSENSORY SX
- Abdomen, oesophagus, chest, throat
- Throat constriction
- Nausea
- eructations, borborygms, gagging, vomiting
  (anterior > posterior insula)

SHE:
- look for auras if any
- gelastic
- latency of HMS after electrical onset (8-20s)
  (anterior sup/inf or posterior insula depending on auras)

SSA:
- limbs/face or midline (throat, back, chest)
- large area or restricted
- spread or not
- pain
- reflex
  (posterior > ant insula)

ICE

SOMATOSENSORY SX
- Motor, gustatory, auditory, psychic, autonomic

(Penfield, 1955; Isnard et al., 2000; 2004; Nguyen et al., 2009; Tran et al., 2014)
(Ryvlin et al., 2006; Dobesberger et al., 2008; Kaido et al., 2006; Proserpio et al., 2011)
(Isnard et al., 2004; Montavont et al., 2015; Nguyen et al. 2009)

Insular spikes can only be seen when they project to the surface

Insular spikes propagation patterns

Scalp interictal EEG in OICE:

• Anterior OICE:
  – Abundant to frequent
  – FP1/FP2
  – F7/F8

• Posterior OICE:
  – Rare to abundant
  – T3/T4 ± F7/F8
    or T5/T6
    or C3/C4
Scalp ictal EEG findings in OICE:

- Various onset patterns:
  - Low voltage fast activity
  - Rhythmic spike and wave
  - Rhythmic alpha activity
  - Rhythmic delta activity
- Predominantly over ipsilateral FT leads
- Except during SSA → no Δ
Case 1 (G.G) A case of nocturnal automotor seizures
Case 1 (G.G.): surface spikes
Case 1 (G.G) Isolated insular spikes:
Continuous rhythmic SW over U1(1-3) [ant short INS gyrus]
Projected spikes
Case 1 (G.G.): surface spikes
Ictal scalp EEG: diffuse spike, attenuation, rhythmic theta
Case 1 (G.G): Ictal icEEG
Propagation: orbiF, IFG, MFG, medialFG
Case 2 (R.W.) A case of nocturnal semi-purposeful behavior and diurnal audiogenic painful seizures
Case 2 (R.W.): L T spk
Case 2 (R.W.): Broader MTG, G1 (26) (ant STG), G1 (34) (ant)
Case 2 (R.W.): Ictal icEEG

Onset P operculum-post INS
Complex motor behaviour
Temporal pole (+orbitoF?)

(continued)
Propagation to rest of temporal lobe and inferior parietal
MRI in OICE

- MRI is the most useful test

MRI in OICE

<table>
<thead>
<tr>
<th>Pathologic Features</th>
<th>Medication</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Response</td>
<td>Refractoriness</td>
<td>P Value</td>
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<tr>
<td>Neoplastic lesion</td>
<td>8</td>
<td>5</td>
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<td>Malformations of cortical development</td>
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<td>10</td>
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<td>Atrophy/gliosis from acquired insults</td>
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<td>.71</td>
<td></td>
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<tr>
<td>Other</td>
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<td>3</td>
<td>.49</td>
<td></td>
</tr>
<tr>
<td>Normal</td>
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<td>3</td>
<td>.62</td>
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<tr>
<td>Total</td>
<td>21</td>
<td>27</td>
<td>.004b</td>
<td></td>
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</tbody>
</table>

*Statistical significance threshold after Bonferroni method, P = .008.

*P value obtained by Fisher exact test on the overall 2 × 6 contingency table (statistical significance threshold P = .05).*

Quantitative MRI

MRS

MEG

- 2nd most useful test

Ictal SPECT

• 3rd best test
  – Correctly identified OI focus in 11/17 (65%)
  – Misleading in 3/17 (18%)
  – Secondary activation in areas known to be connected to the insula

Fei P, Soucy JP, Obaid S, Boucher O, Bouthillier A, Nguyen DK. The value of SPECT and PET in OIE (submitted)
Interictal PET

- Concordant with OI focus in 8/17 (47%)
- Misleading in 4/17 (24%)

Fei P., Soucy JP, Obaid S, Boucher O, Bouthillier A, Nguyen DK. The value of SPECT and PET in OIE (submitted)
Genetic testing

Temporal plus epilepsies

- Temporo-perisylvian epilepsies
  - Temporo-insular epilepsies
  - Temporo-operculo-insular epilepsies

Temporal plus epilepsies

Atypical Clinical, EEG, and Neuroimaging Findings Suggesting Temporo-Insular/Temporoperisylvian Epilepsy

Occurrence during sleep, reflex seizure, subjective manifestations such as throat/laryngeal constriction or breathlessness sensation; orofacial paresthesiae; shivers or goose bumps, painful paresthesiae, gustatory hallucinations
Bradydys, facial or faciobrachial jerks ± secondary tonic–clonic generalization, hypermotor component
Temporo-frontal or temporo-central interictal/ictal EEG abnormalities, rapidly spreading to the contralateral hemisphere
Extended temporo-insular hypometabolism

IcEEG/SEEG

- Non-invasive tools can provide additional clues supporting clinical suspicion

- Confirmation of insular seizures still requires an icEEG study in many, especially in nonlesional cases


Surgical treatment of ICE

- Selective insulectomy
- Subpial operculo-insulectomy
- Insulectomy combined with a lobectomy

Surgical treatment of ICE

Vascular consequences of operculo-insular cortectomies

Vascular consequences of operculo-insular cortectomies

- 20 consecutive cases (2004-2013) (4 dominant)

- 12/20 (60%) had IL
  - 11 (55%) related to insular cortectomy
  - 1 related to periinsular resection

Seizure outcome

• 25 insular resections
  – 23 combined with opercular resection
  – 7 in dominant hemisphere

• Engel 1 in 80% (FU 4.7 years; range 1-16)

Complications

• ‘Neurosurgical’ complications:
  – No new permanent motor or language deficits
  – 40% transient hemiparesis
  – 86% transient dysphasia in dominant hemisphere

Complications

• ‘Neurological’ complications:
  – 2 operculo-insular central pain syndrome
  – 1 hyperacusis
  – 1 tinnitus
  – 1 transient hyperosmia
  – 1 transient altered taste
  – 1 contralateral postural tremor
Neuropsychological complications: standard test battery

- No significant mean difference between the two assessments on any outcome except...

Deterioration of only one outcome – the color naming condition of the Stroop test – which relies on oro-motor speed and lexical access.
Experimental test battery: impaired ability to recognise facial expressions of emotions

Impaired decision making in the context of risk

Iowa Gambling

Disturbance of personality

- Iowa Scales of Personality Change
- Insular resections were associated with mild but significant increases in irritability, emotional lability, anxiety, and frugality postoperatively, which, with the exception of increased anxiety, were not found among temporal patients.
- Changes were relatively mild for the vast majority of patients

Alternative treatments

• Gamma-knife

• RNS

• Thermocoagulation

• Laser ablation

Hawasli, 2014; Irislimane, 2013; Smith, 2010;
Summary

- Insula = not only a primitive ‘visceral brain structure’ but implicated in several functions: multisensory and pain processing (intensity modulator), emotional experience, empathy, social cognition, motivation, and decision-making
- IE semiology: great mimicker? Not if you know its role, function and connectivity
- Non-invasive tests: MRI > MEG > SPECT > PET
- Scalp EEG: F, T > C, P
- For TIE: not clear, not easy, similar reasoning
- icEEG/SEEG: still very much pertinent
- Surgery: possible w/ acceptable risks in experienced hands
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Questions?