

Corpus Callosotomy

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ANATOMY, PHYSIOLOGY of corpus callosum – see p. A143 >>	

Reading

M.S. Park, E. Nakagawa, M.R. Schoenberg, S.R. Benbadis, F.L. Vale. Outcome of corpus callosotomy in adults. *Epilepsy Behav*, 28 (2) (2013), pp. 181-184

HISTORY

- first reported in 1939 (Van Wagenen and Herron), refined by Wilson in 1970s.
- formerly, various additional structures were sectioned - anterior commissure, hippocampal commissure, massa intermedia, unilateral fornix.
- in recent years, only corpus callosum has been sectioned.

EXTENT OF PROCEDURE

- extent of sectioning necessary for *maximum seizure control* with *minimum risk of disconnection syndrome* (mutism, left-sided apraxia resembling hemiparesis, bilateral frontal lobe reflexes) is not known.
- best seizure results come from complete callosal section.

80-90% section sparing *splenium* seems to be optimal.

- advisable to perform in **two stages** (anterior-posterior) - avoids acute prolonged apathy and confusion seen after complete division in single stage
 1. First stage resects **anterior 2/3** of corpus callosum.
 2. If necessary, **complete** callosotomy is performed at second stage (↑risk of disconnection syndrome)

INDICATIONS

- rarely performed today (replaced by **vagus nerve stimulation**; in the past, Corpus Callosotomy was the only applicable surgery for **GENERALIZED seizures**).
- no clearly defined indications - medically refractory primarily and secondarily **GENERALIZED seizures** (esp. Lennox-Gastaut syndrome*).
 - *treatment of choice for Lennox-Gastaut syndrome is **vagal nerve stimulator** or **RNS/DBS** for centromedian nucleus
- **atonic seizures (drop attacks)*** are helped most significantly, but having atonic seizures does not guarantee benefit from surgery (seizures still occur as partial seizures, but they do not result in falls).
 - *frequent facial and neck injuries due to fall
- **complex partial seizures** can be reduced in $\approx 50\%$ patients, but exacerbated in $\approx 25\%$.
- **mentally handicapped patients** fare less favorably.
- aim is to REDUCE SEIZURE FREQUENCY (vs. resective surgery – to achieve SEIZURE-FREE OUTCOME); additional goals of social or vocational rehabilitation are not realistic expectations.
 - N.B. callosotomy disrupts EEG bilateral synchrony but does not eliminate epileptiform discharges!

PREOPERATIVE TESTS

- 1) **tests for interhemispheric transfer** (incl. cross-retrieval and naming of objects, cross-replication of hand postures, cross-localization of fingertips); routine extensive neuropsychological testing is not required.
- 2) **Wada testing** - if **mixed cerebral dominance** for handedness and language exists (e.g. right-handed person with right-hemisphere language dominance) - risk for *postcallosotomy language impairments*.
- 3) selective **visual field testing**.
- 4) coronal **MRI** – may find *singular (s. simian) pericallosal artery*.

PROCEDURE

- now can be done with laser ablation.

ANESTHESIA

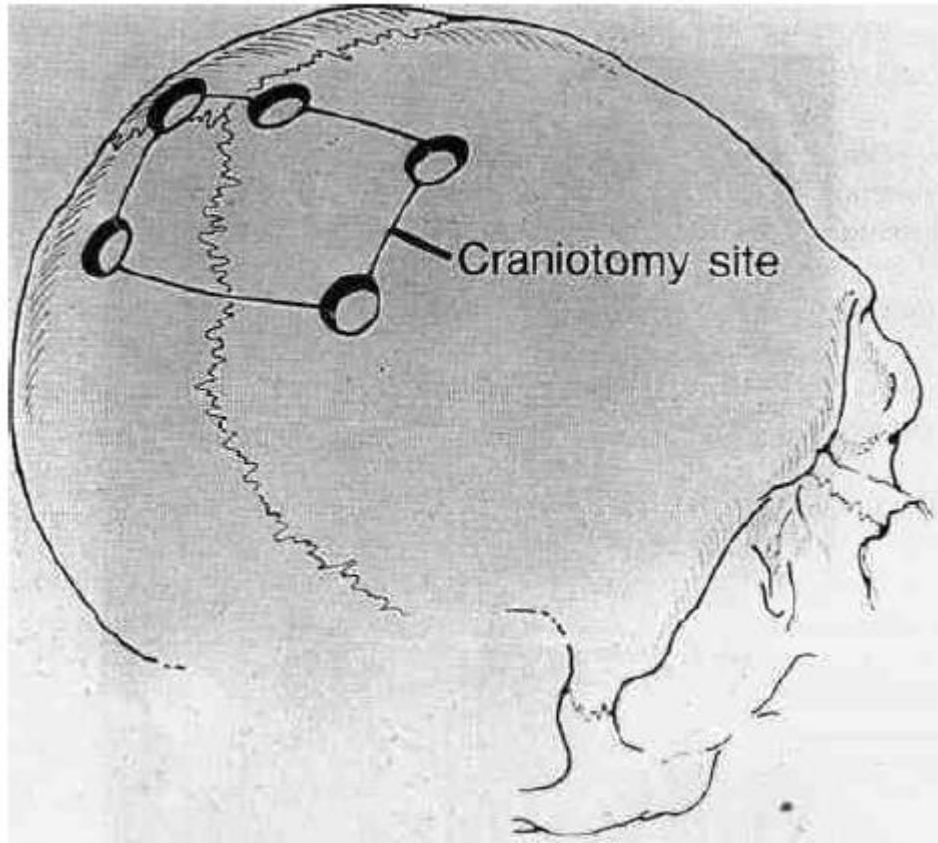
- most dangerous complication is **air embolism** (from tear in superior sagittal sinus).
- **bleeding** from sagittal sinus can be extensive, with significant blood volume loss accumulating rapidly (one policy is not to begin surgery without transfusable blood in operating room for pediatric cases).
- patients undergoing callosotomy with narcotic anesthesia often are slow to arouse immediately after surgery and therefore are difficult to evaluate neurologically (thus, some have abandoned narcotic anesthesia in favor of **inhalation agents**).
- **lumbar drain** can be placed - to allow CSF drainage for improved exposure until callosum is sectioned.

POSITION

- a) **supine position** (favored by most surgeons) - necessitates frontal lobe retraction.
- b) **lateral decubitus position** with side for craniotomy dependent ("hanging hemisphere" approach) - to allow gravity to pull dependent hemisphere gently away from falx; it may be necessary to support superior hemisphere by retractors when falx does not extend far inferiorly between hemispheres.

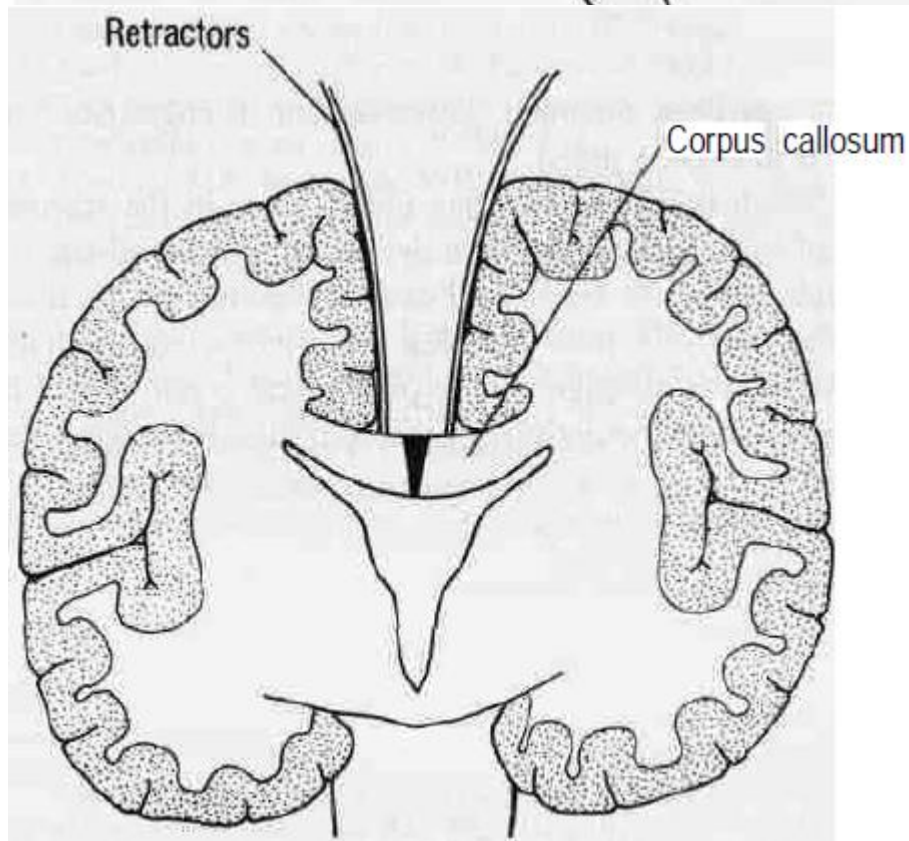
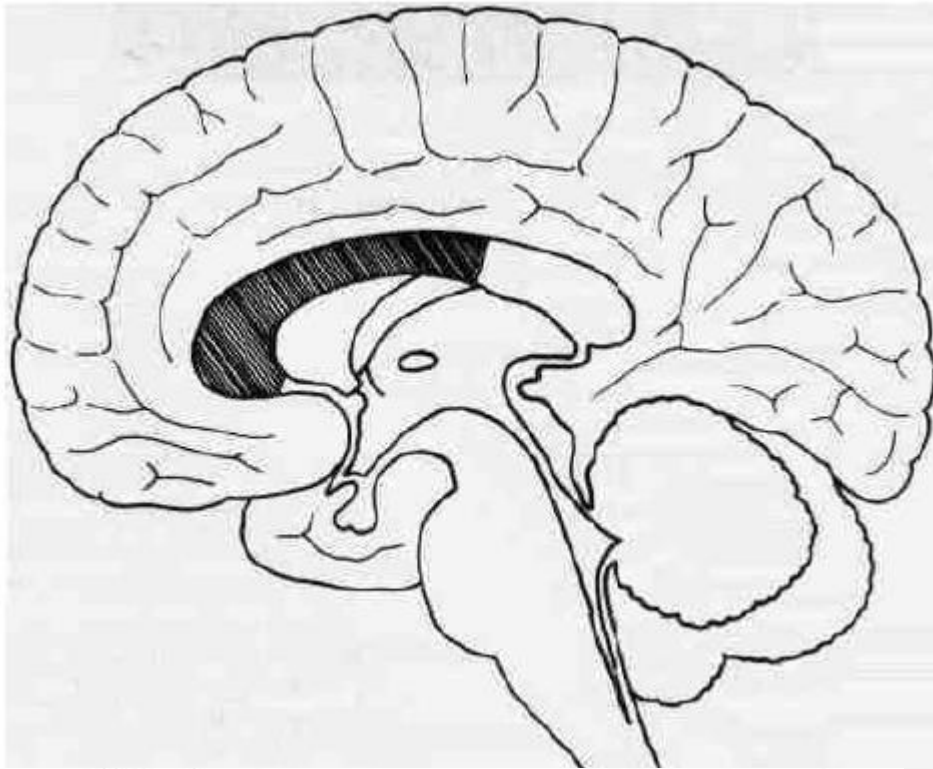
- Mayfield frame, neck secured in neutral position.
- operating table is tilted at head up incline of 15°.

INCISION & DISSECTION



- **rectilinear vertex scalp incision** is centered over junction of coronal and sagittal sutures.
 - in intact patients with dominant left hemisphere, approach is from right, but if there is evidence of damage to left hemisphere or if cortical vein position interferes with approach from right, approach from left is preferred.
- 4-hole **bone flap** is elevated.
- alternative – **bifrontal craniotomy**.
- from this point, **operating microscope** is used; to provide superior stability, may operate while seated, using sterile draped Mayo stand for elbow support.
- **dura** over dependent hemisphere is opened to edge of sagittal sinus. The dural flap is pulled tight with retention sutures to provide maximum exposure of interhemispheric fissure.
- problem where falx ends – sometimes cingulate gyri are adherent – dissect meticulously (esp. vessels) – **lysis of midline adhesions** between arachnoid and dura is performed using bipolar cautery.
- attempt to preserve **bridging veins**, but 1 or 2 veins (anterior to coronal suture) can be sacrificed, if necessary.
- moist cottonoid strips are placed over medial frontal cortex of dependent frontal lobe, and any additional adhesions between cortex and falx are cut with bipolar cautery.
- dissection is carried down to corpus callosum, which is identified only after clear visualization of both **pericallosal arteries** (without this verification, inexperienced surgeon may mistake cingulate gyrus for callosum).

CALLOSOTOMY



- after both *pericallosal arteries* are separated and protected and callosum has been exposed (white structure), callosum is opened along midline of body by semisharp dissector or by suction.
- incision is carried deep until cavum septum pellucidum is entered, leaving ventricular ependyma intact.
- in rare instances, one major pericallosal artery supplies both hemispheres and makes dissection more difficult because artery must be manipulated from side to side without damaging branches to either hemisphere.

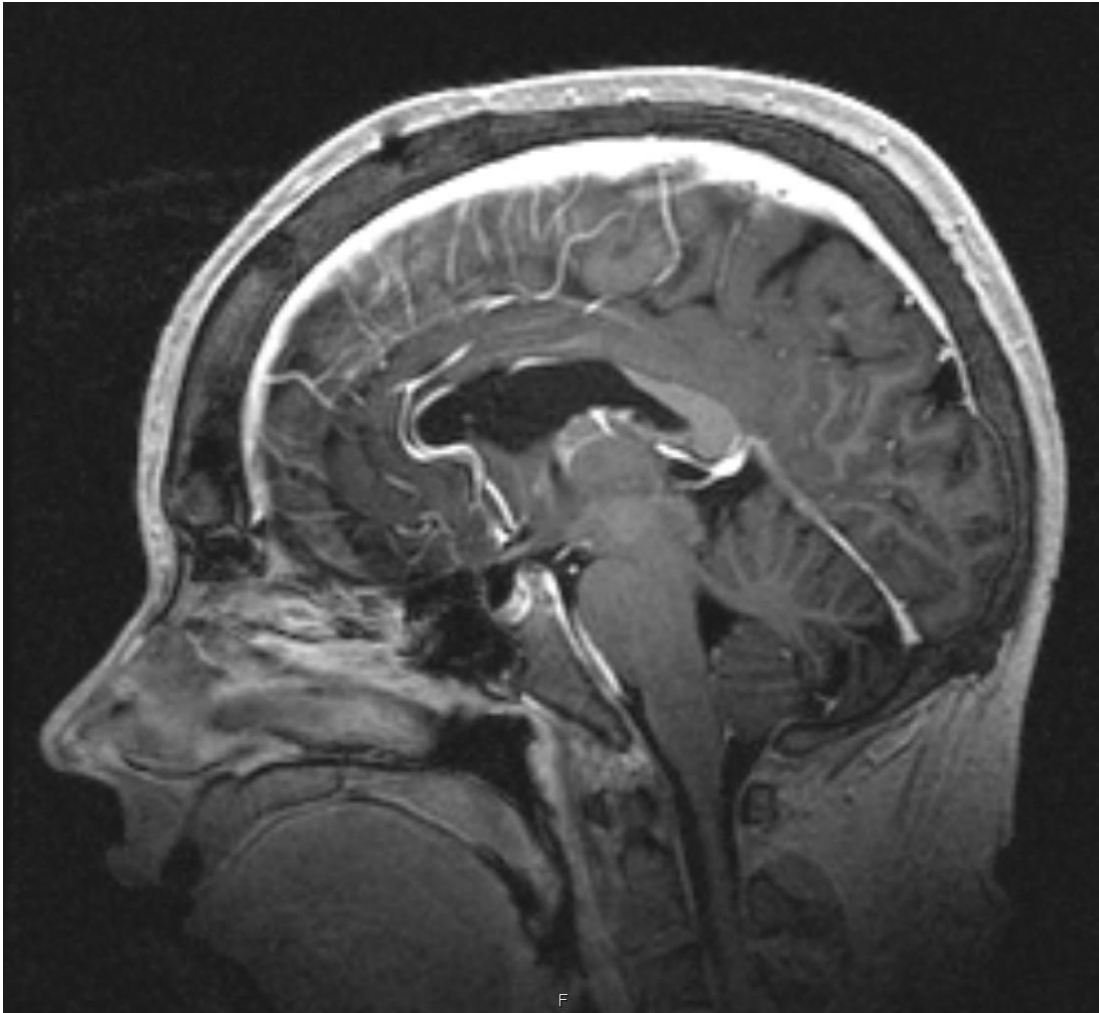
- **bipolar cautery & suction** are used to cut callosum.
- care is taken to stay within cavum septum pellucidum and **avoid entry into ventricle** (→ chemical meningitis that might be fatal)
- entire rostrum, genu, and body are divided, and dissection is carried posteriorly until **only splenium remains intact**; MRI-compatible clip may be applied at posterior extent of section for reference.
- no need to section anterior commissure.
- some advocate sectioning CC with **intraoperative EEG** until typical bisynchronous discharges become asynchronous.
- if second stage is required, craniotomy is performed using more posterior bone flap, and remaining corpus callosum is sectioned; extent of section may be recorded by MRI after each stage.

END OF PROCEDURE

- lumbar drain is removed.
- wound is irrigated generously to replace most of drained CSF.
- dura is closed, dural tack-up sutures secured, and craniotomy closed in layers.

POSTOPERATIVE CARE

- patient needs to be watched particularly closely for first 24 hours - neurologic parameters may fluctuate and be complicated by **disconnection syndrome**.
- patient may not verbalize readily or respond quickly and may have unexplained pupillary inequality (CT scan can rule out clot or tension pneumocephalus).
- by POD#2, normal baseline neurological status should begin to return.
- patient is maintained on same anticonvulsant regimen as before surgery (seizures may increase transiently during postoperative first week).
- MRI - evaluate extent of sectioning:



Source of picture: Viktoras Palys, MD >>

COMPLICATIONS

- 1) **air embolism, excessive bleeding** from superior sagittal sinus
- 2) **frontal lobe edema**
- 3) **hydrocephalus** and **aseptic meningitis** (up to 50% in early series) - partly due to **opening ependyma into ventricles**; can be minimized by entering only cavum septum pellucidum.
- 4) **venous infarction** (from sacrificing major bridging veins).
- 5) transient left-sided **hemiparesis** (lateral decubitus positioning may eliminate much of this problem).
- 6) temporary **bladder incontinence** (damage to cingulate gyrus).
- 7) **disconnection phenomena (split brain)**: lethargy, transient mutism, apathy, confusion, left tactile anomia, ideomotor apraxia of nondominant hand, impaired spatial synthesis of right hand resulting in difficulty copying complex figures, incontinence.
 - may be observed for 3-4 days.
 - patients usually adapt after 2-3 months, with final function normal for most daily activities (deficits may show up on neuropsychological testing); long-term sequelae with anterior corpus callosotomy are extremely rare but reported.
 - in past, when complete callosotomy was done in single stage, disconnection phenomena were prolonged.
 - some experts state, even in complete callosotomies, syndrome may be mild in some patients.

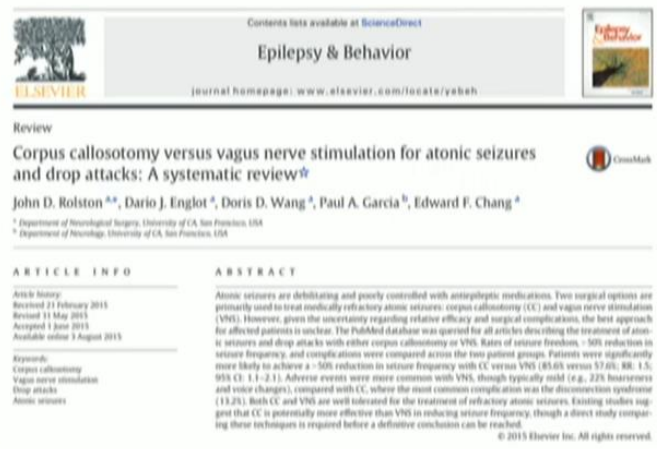
Dr. Cukiert: disconnection syndrome lasts 2-3 weeks (i.e. it is a transitory effect and not a complication).

- *intermanual conflict* ("alien hand" syndrome) following complete corpus callosotomy may be incapacitating and prolonged.
- *persistent severe aphasia* have been reported with partial and total corpus callosotomies in right-handed patients with language function located in right hemisphere ("crossed dominance") - Wada test is recommended in all left-handed patients.

8) **increase in aggressive outbursts** in some children with mental handicaps (some patients are more alert and more aware of their surroundings after surgery and, hence, may be frustrated more easily).

OUTCOMES

- CC is more effective than VNS but also increased morbidity.



Corpus callosotomy better than VNS for drop attacks (85.6% responder rate vs. 57.6%; Rolston et al., 2015)

- *bilateral synchronous discharges* – abolished in 50% patients after anterior callosotomy.
- anterior 2/3 CC gives 58% **seizure freedom** (adding splenium – gives additional 10%); other data shows only 2-5% seizure freedom.
- CC is effective for both drop seizures and other generalizing epilepsy types;
 - Drop seizures – 60-100% responder rate (> 50% seizure reduction)
 - GTC – 21-67% responder rate (> 50% seizure reduction)
- earlier age at surgery - lower risk and better outcome (**younger age** at surgery correlates with better seizure outcomes).
- corpus callosum also has inhibitory tracts – **partial seizures** may worsen postop.

Seizure persistence: check DTI for remaining fibers!

MODIFICATIONS

ENDOSCOPIC-ASSISTED CORPUS CALLOSOTOMY COMBINED WITH ANTERIOR, HIPPOCAMPAL, AND POSTERIOR COMMISSUROTOMY

- endoscopic CC same op time as open CC.
- through a mini craniotomy.

Chandra, Sarat P. Endoscopic-Assisted (Through a Mini Craniotomy) Corpus Callosotomy Combined With Anterior, Hippocampal, and Posterior Commissurotomy in Lennox-Gastaut Syndrome: A Pilot Study to Establish Its Safety and Efficacy. Neurosurgery: May 2016 - Volume 78 - Issue 5 - p 743-751

Results in 16 patients with Lennox-Gastaut syndrome (drop attacks) with moderate to severe mental retardation

Chandra, P. Sarat MCh; Kurwale, Nilesh MCh*; Garg, Ajay MD‡; Dwivedi, Rekha MPhil*; Malviya, Shri Vidya MPhil, PhD*; Tripathi, Manjari DM "Endoscopy-Assisted Interhemispheric Transcallosal Hemispherotomy: Preliminary Description of a Novel Technique" Neurosurgery April 2015 - Volume 76 - Issue 4 - p 485-495*

LITT CALLOSOTOMY

- MIS CC increases pt / family acceptance rate.
Dr. Taylor Abel would choose LITT (vs open) CC for his own child.
- longer OR time (4-8 hrs), shorter LOS.

Indications

- given that reoperation and dissection of a scarred interhemispheric fissure is technically challenging and associated with a higher risk of surgical complications, LITT is especially useful in **failed anterior 2/3 CC**.

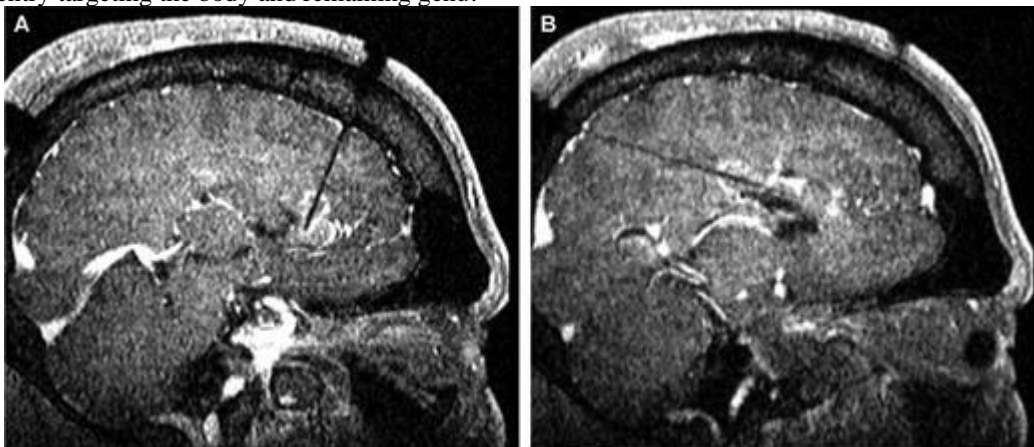
Cautions

- check **corpus callosum shape** - **thin corpus** ["nothing to disconnect"] or **very curved corpus** ["need > 4 trajectories"] - LITT is less desirable.
- avoid ablating cingulum ← risk of weakness

Technique

- three probes.
- some corpus cal areas may be missed with LITT.
- usually need 3 laser trajectories (consider treating in stages because brain shifts).
- if CC is not very curved, all LITT trajectories could be done from one posterior entry bur hole (using robot).
- do on one (nondominant) side and ablate full thickness of CC.

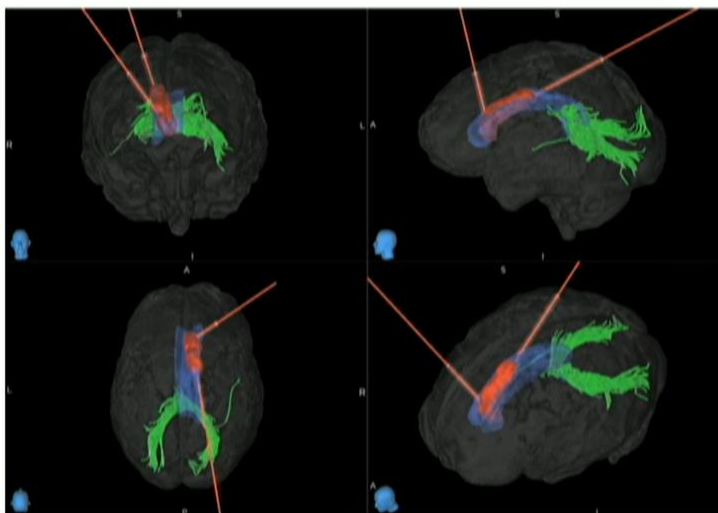
2 laser fiber trajectory technique to an anterior laser corpus callosotomy. **A**, Frontal entry targeting the rostrum and genu. **B**, Parietal entry targeting the body and remaining genu:



Outcomes

- LITT may be inferior to open CC but lower complication rate. H: check DTI for remaining fibers - may repeat LITT.

- 10 patients
- 6 had > 80% seizure reduction, of whom 2 were seizure free
- 8 had > 80% reduction in drop attacks
- Mean hospital stay: 1 day
- No major permanent adverse effects



Ablated areas: red, preserved areas: green

Tao JX et al. Epilepsia 61:1190, 2020

Category (No. of all cases/No. of atonic cases)	Complete overall seizure freedom	Excellent seizures control (Engel I + Engel II)	Complete atonic seizure freedom	Excellent atonic seizures control (Engel I + Engel II)
All LITT cases (57/40)	21.1%	49.1%	52.5%	72.5%
LITT cases with no prior surgical callosotomy (42/30)	19%	50%	46.7%	73.3%
Anterior LITT cases (33/26)	21.2%	54.5%	46.2%	73.1%
Posterior LITT cases (20/12)	20%	45%	67.7%	75%
All LITT cases with ≥ 12 months of follow-up (40/34)	27.5%	57.5%	52.9%	70.6%

Complications:
 Hemorrhage: 8.6%
 Inaccurate placement: 6.9% with transient signs

A Awad and K Kaiser Seizure 96:137, 2022

BIBLIOGRAPHY for ch. "Epilepsy and Seizures" → follow this [LINK](#)

