

Stereotactic Biopsy of Diffuse Pontine Gliomas

Michael H. Handler M.D.

The Children's Hospital and
University of Colorado School of Medicine

Stereotactic

stereo meaning solidity, hardness, or
three-dimensionality

taxis referring to order or arrangement

Any technique that involves the
recording and reproducing of three-
dimensional information or creating
an illusion of depth to the sense of
touch

Stereotactic Surgery

A minimally-invasive surgical
technique

Uses a Cartesian coordinate system

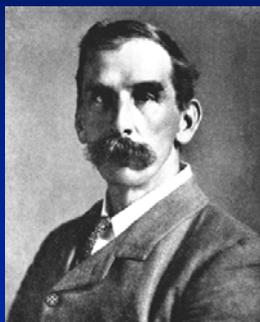
Locate small target

Perform some intervention:

Biopsy, injection, stimulation,
targeted radiation, or resection

Stereotactic Surgery

Idea is nearly as old as neurosurgery
itself



Victor Horsley



Horsley Clarke animal frame--1906

Stereotactic Surgery

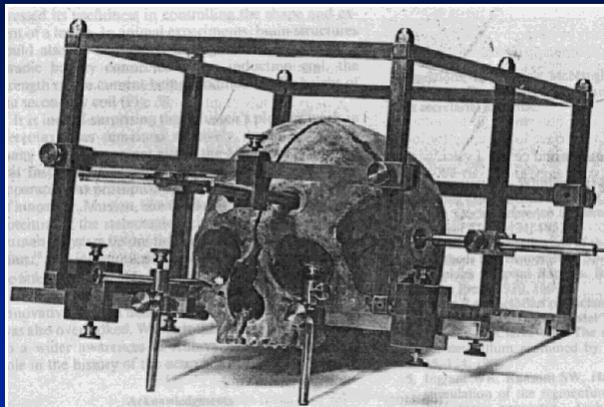
Research tool in animals

Extensive experience in early 20th
century

Correlation with detailed atlases

Stimulation and ablation of deep
brain structures

Stereotactic Surgery



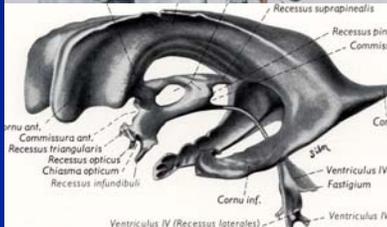
Mussen frame, 1918

Stereotactic Surgery

Problem: no good reliable
correlation between external
landmarks and brain structures

Need a way to establish internal
references

Air Ventriculogram



Stereotactic Neurosurgery

Marked expansion after WW II

Refinement of internal landmarks

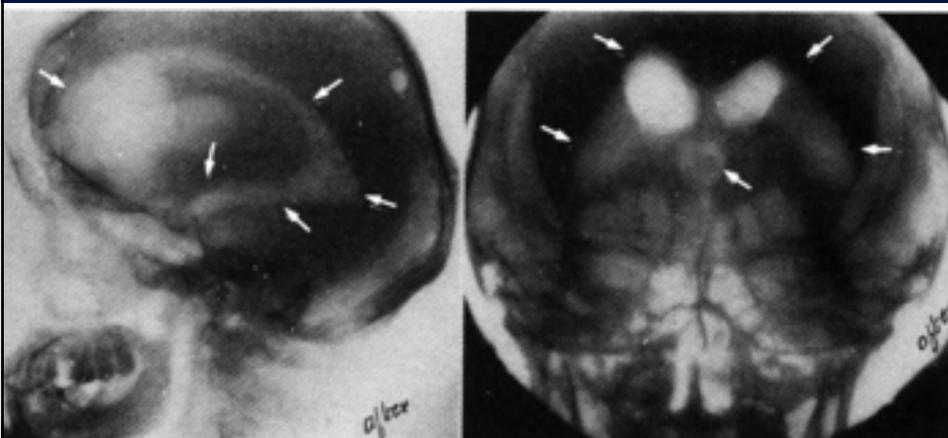
Psychosurgery, as alternative to
frontal lobotomy

Surgery for movement disorders

Poor ability to visualize lesions

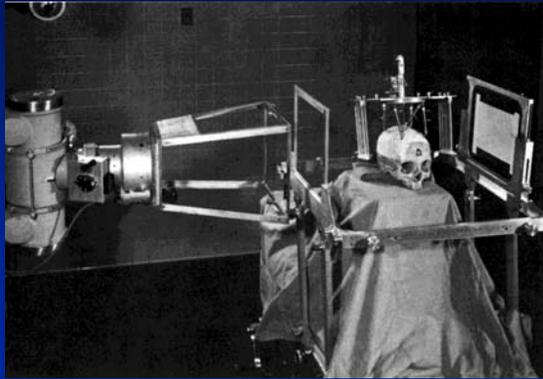
Declined with effective medication

Air Ventriculogram



Stereotactic Surgery

Dependent on imaging



Spiegel and Wycis Frame--1956

Resurgence of Stereotaxy

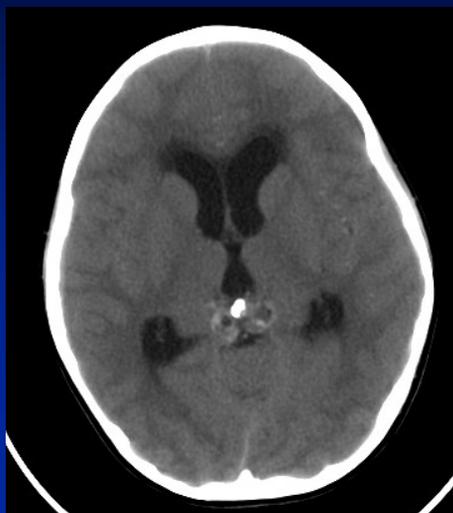
CT scan became widespread in mid
1970s

Clear ability to identify and localize
intracranial landmarks and lesions

Brown and others developed
localizing systems linked to images

Accurate biopsies now feasible

CT Image of Small Lesion



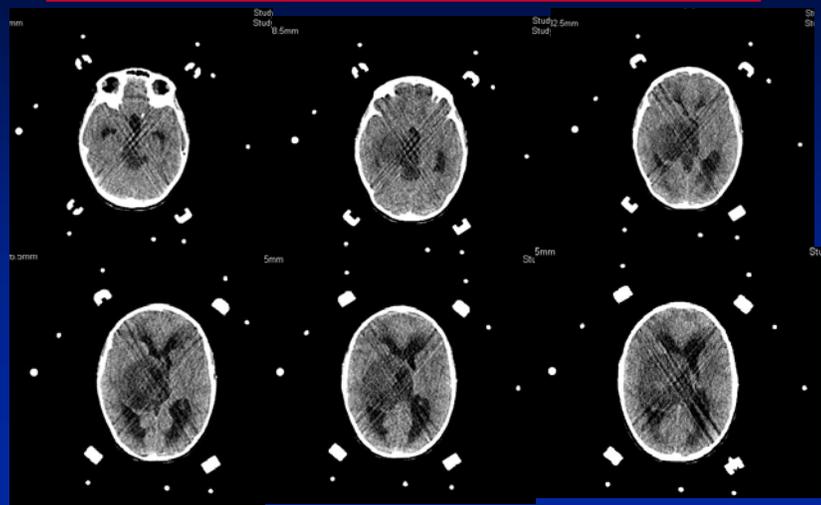
Stereotactic Biopsy

- Affix frame to head
- Acquire scan
- Calculate trajectory to target
- Rigid frame directs biopsy instrument
- <1mm accuracy

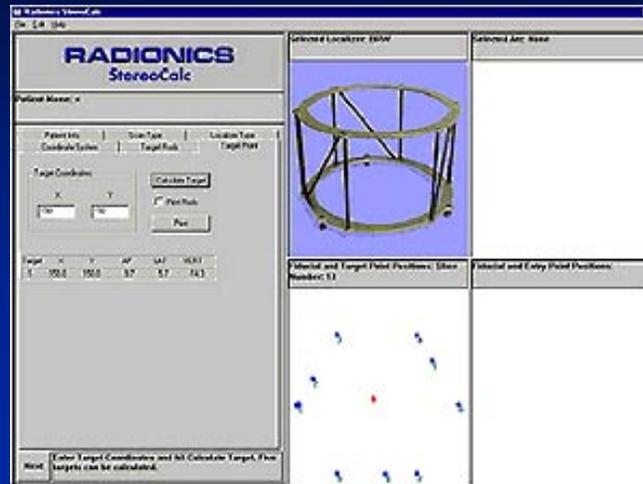
Stereotactic Biopsy



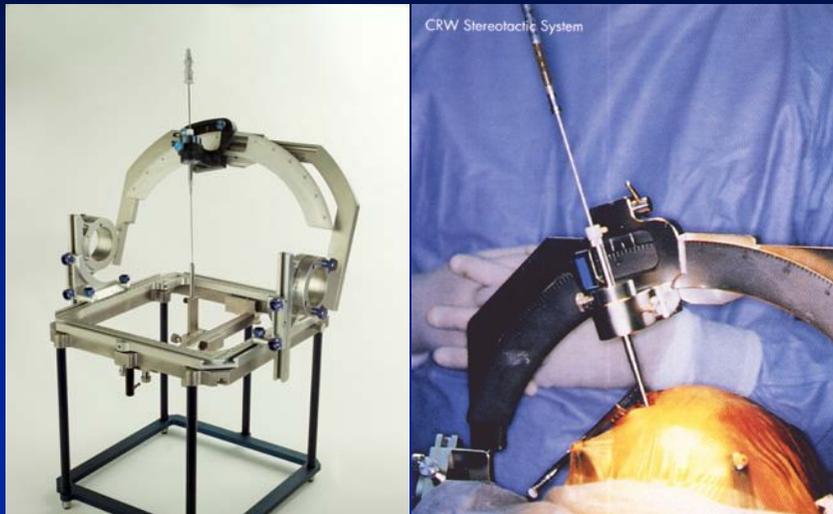
Stereotactic Biopsy



Stereotactic Biopsy



Stereotactic Biopsy



Stereotactic Biopsy

Rapid experience accrued in 1980s

Safety well established

Deep lesions as amenable to biopsy
as superficial

Questions about adequacy of
samples gradually subsided

Unquestionably effective technique

Quickly adapted to MRI

Stereotactic Needle Biopsy

“Experience in 300 cases of CT-
directed stereotactic surgery for
lesion biopsy and aspiration of
haematoma.” Thomas and Nouby, *Br J
Neurosurg.* 1989;3(3):321-5.

Diagnosis in 92.8%

Complications 4.7%

1 Death (0.3%)

Stereotactic Needle Biopsy

“Stereotactic biopsy of deep brain tumors in infancy and childhood.”

Broggi et al., *Child's Brain* 1983;10(2):92-8

17 pediatric patients, deep lesions including 2 in brain stem safely biopsied

Stereotactic Posterior Fossa Biopsy

“Transcerebellar biopsy in the posterior fossa: 12 years experience.” Mathisen et al., *Surg Neurol.* 1987 Aug;28(2):100-4.

29 cases, 12 children

28 diagnostic

No serious side effects

Stereotactic Brainstem Biopsy

“Computer-directed stereotactic biopsy of intrinsic brain stem lesions.” Thomas et al., *Br J Neurosurg.*

1988;2(2):235-40.

12 patients

11 diagnoses

No mortality, minimal morbidity

Stereotactic Brainstem Biopsy

“Results and expectations with image-integrated brainstem stereotactic biopsy.” Kondziolka and Lundsford, *Surg Neurol.* 1995 Jun;43(6):558-62

40 patients in 13 years

95% diagnosis

1 transient diplopia

Stereotactic Brainstem Biopsy

“Stereotactic biopsy of brainstem
mass lesions.” Steck and Friedman, *Surg
Neurol.* 1995 Jun;43(6):563-7

24 patients, 10 years

92% diagnosis

1 worsened hemiparesis

1 death

Stereotactic Brainstem Biopsy

“Computerized tomography-guided
stereotactic surgery for brainstem
masses: a risk-benefit analysis in
71 patients.” Rajshekhar and Chandy, *J*

Neurosurg. 1995 Jun;82(6):976-81

98.5% diagnoses

7% Morbidity, 1 permanent

No mortality

Stereotactic Posterior Fossa Biopsy

“Stereotactic biopsy of brain stem and
posterior fossa lesions in children.”

Valdes-Garcia et al., *Acta Neurochir (Wien)*.

1998;140(9):899-903

30 patients

Diagnosis in 97%

No morbidity

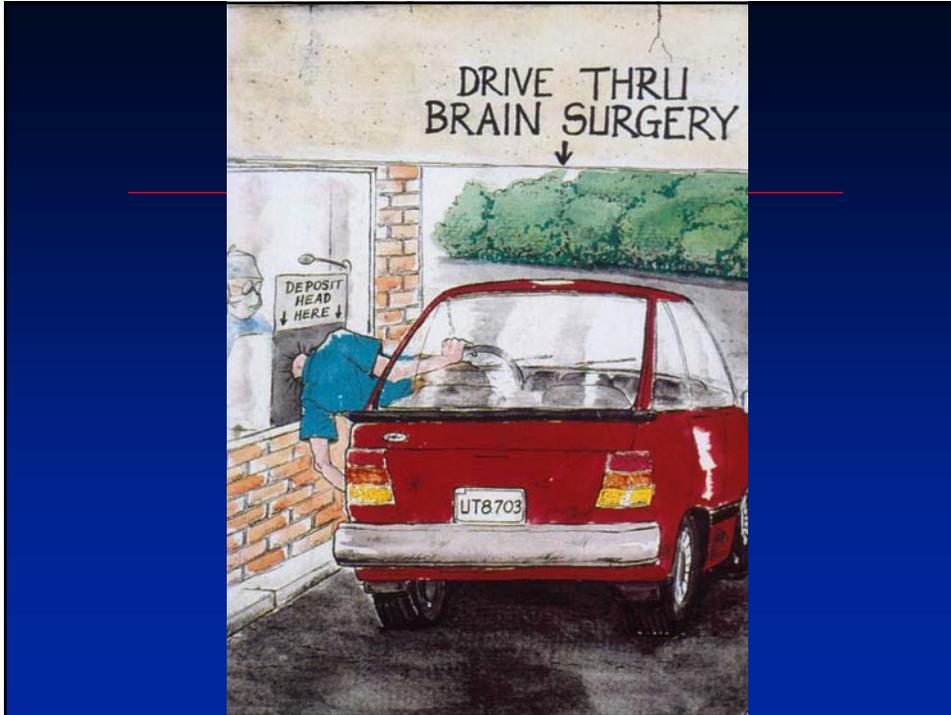
Stereotactic Biopsy

“Prospective feasibility study of
outpatient stereotactic brain lesion
biopsy.” Bhardwaj and Bernstein, *Neurosurgery*. 2002

Aug;51(2):358-61

76 patients with intended outpatient brain
biopsy

2 admissions: IV antibiotics, failed Bx



Stereotactic Biopsy

“Haemorrhagic complications and the incidence of asymptomatic bleeding associated with stereotactic brain biopsies.” Grossman et al., *Acta Neurochir* (Wien). 2005 Aug;147(8):911-2.

355 stereotactic brain biopsies
3.4% asymptomatic hemorrhage
3.4% symptomatic hemorrhage
Death in 0.6% (N=2)

Stereotactic Brainstem Biopsy

“Brainstem stereotactic biopsy
sampling in children.” Pincus et al., *J
Neurosurg.* 2006 Feb;104(2 Suppl):108-14

10 patients, all diagnostic

Frameless stereotactic technique

1 transient diplopia

Stereotactic Brainstem Biopsy

“Stereotactic biopsy of diffuse
pontine lesions in children.” Roujeau et
al., *J Neurosurg.* 2007 Jul;107(1 Suppl):1-4

24 patients, all diagnostic

Transcerebellar approach

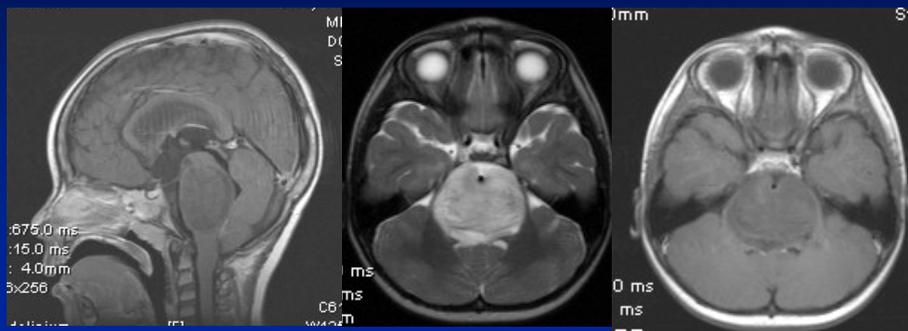
2 transient morbidities

Stereotactic Brainstem Biopsy

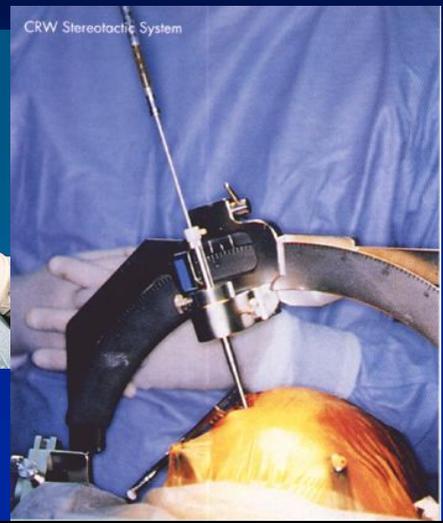
“Stereotactic biopsy of brain stem masses: Decision analysis and literature review.” Samadani et al., *Surg Neurol.* 2006 Nov;66(5):484-90

Metanalysis of 378 patients
6.6% transient complication
1.5% permanent new deficit
0.5% mortality.

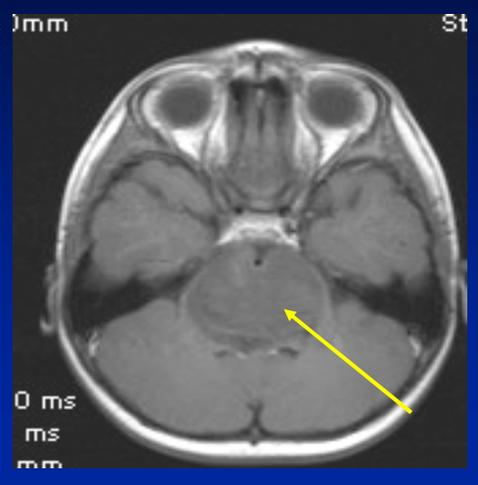
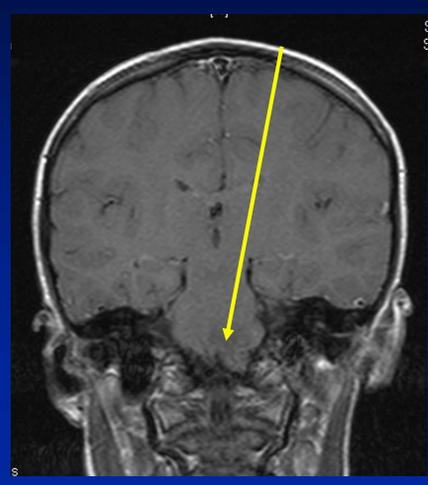
Diffuse Pontine Glioma



Stereotactic Brainstem Biopsy



Frontal vs. Transcerebellar



Frameless Stereotaxy

Stored MRI or CT

Registration to camera system

Intraoperative tracking of instruments

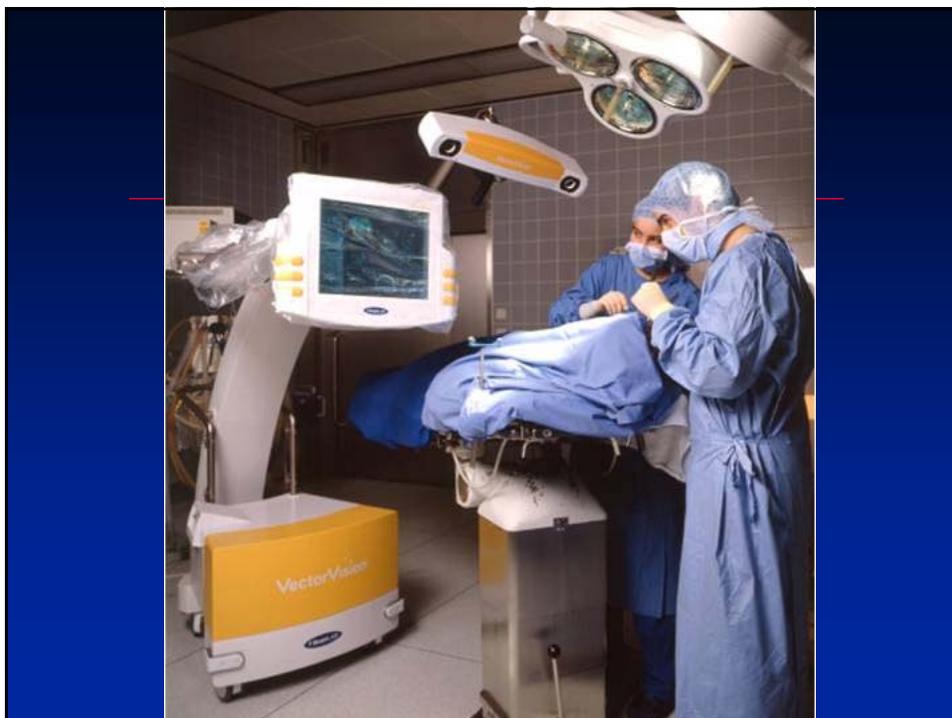
Guide to location of lesion, extent of
resection="image guidance"

Does not encumber the operative
field

Frameless Stereotaxy



Fiducial markers



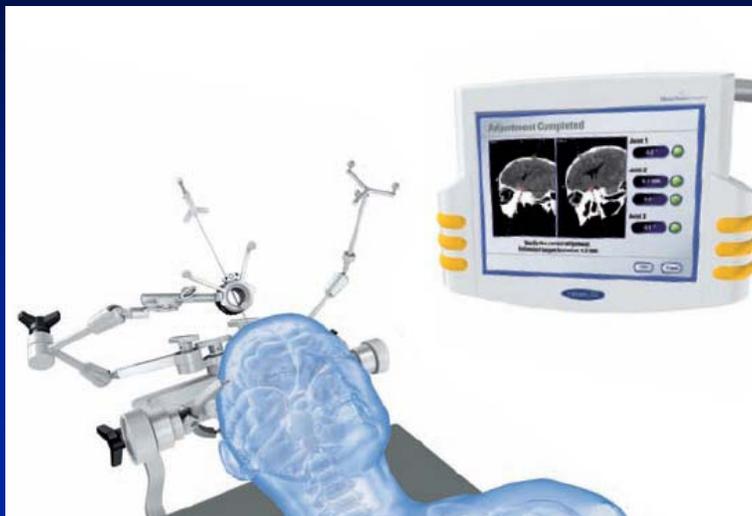
BrainLAB



Image guidance system

Ceiling mounted system with no footprint
Pre-configured screen setup for fast and direct control through VectorVision sky touch screen
Simultaneous display of patient data, live video, navigation and diagnostic information

Frameless Stereotactic Biopsy

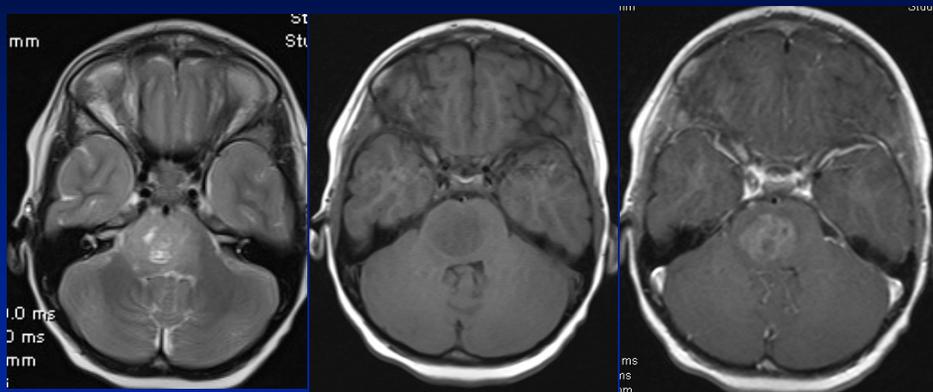


Frameless Biopsy Guidance

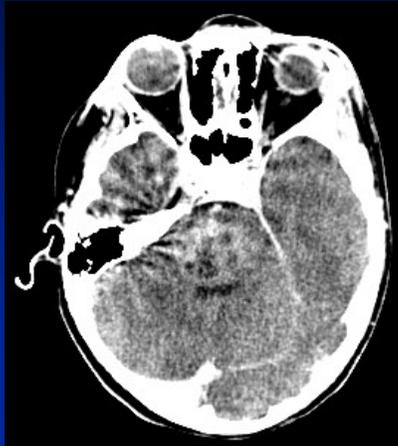
BrainLAB VarioGuide software wizard



Stereotactic Brainstem Biopsy



Stereotactic Brainstem Biopsy



Pre biopsy



Post biopsy

Stereotactic Brainstem Biopsy

“Diffuse brainstem gliomas in children: should we or shouldn't we biopsy?” Leach et al., *Br J Neurosurg.* 2008 Oct;22(5):619-24

“The authors believe that there is an increasing need for performing a biopsy of these lesions.”

Stereotactic Brainstem Biopsy

“Treatment of diffuse intrinsic brainstem gliomas: failed approaches and future strategies.” Frazier et al., *J Neurosurg Pediatr.* 2009 Apr;3(4):259-69.

“... the discussion includes a rationale for stereotactic biopsies as well as possible therapeutic options of local chemotherapy in these lesions.”

Stereotactic Brainstem Biopsy

“Only a concerted effort by all of those who wish to change the outlook for this dreadful disease will offer a realistic chance of success!”—Darren Hargrave, *Br J Neurosurg.* 2008 Oct;22(5):624.

Stereotactic Brainstem Biopsy

“It surprises those of us treating adults with brain stem tumours that there appears reluctance in the paediatric world to perform a biopsy... We owe it to current and future patients to biopsy brain stem tumours.” —Andrew Brodbelt, *Br J Neurosurg.* 2008 Oct;22(5):625

