Stereotactic Biopsy of Diffuse Pontine Gliomas

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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

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

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


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

29 cases, 12 children
28 diagnostic
No serious side effects
Stereotactic Brainstem Biopsy

12 patients
11 diagnoses
No mortality, minimal morbidity

Stereotactic Brainstem Biopsy

40 patients in 13 years
95% diagnosis
1 transient diplopia
Stereotactic Brainstem Biopsy

24 patients, 10 years
92% diagnosis
1 worsened hemiparesis
1 death

Stereotactic Brainstem Biopsy

98.5% diagnoses
7% Morbidity, 1 permanent
No mortality
Stereotactic Posterior Fossa Biopsy

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


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


10 patients, all diagnostic

Frameless stereotactic technique

1 transient diplopia

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**Stereotactic Brainstem Biopsy**


24 patients, all diagnostic

Transcerebellar approach

2 transient morbidities
Stereotactic Brainstem Biopsy


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

Fiducial markers
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

“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


“... 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