Meningioma Diagnosis

Neuroimaging

Meningioma Neuroimaging.

Meningioma sampling

Intraoperative sampling methods during meningioma resection vary among neurosurgical departments. There is need for a structured sampling to optimize the diagnostic yield of CNS invasion [1].

Dal Col et al. have shown that a correct grading of more than 95% of meningiomas can be achieved when at least six slides are examined. They suggests that meningioma sampling might be an issue and the sampling system must be specified in research works on grading [2]

Features

Pathologically, meningiomas are characterized by the following features:

Histological Subtypes: Meningiomas can be classified into various histological subtypes based on their appearance under a microscope. The World Health Organization (WHO) classifies meningiomas into different grades, including Grade I (benign), Grade II (atypical), and Grade III (malignant).

Cellular Composition: Meningiomas are composed of abnormal, proliferating meningothelial cells that originate from the arachnoid cap cells. These cells form whorls or sheets and may have variable cellularity.

Tumor Features: Meningiomas often have a well-defined border or encapsulated appearance, which allows for easier surgical removal. The tumor cells may exhibit different growth patterns, such as syncytial, fibroblastic, transitional, or psammomatous (calcification).

Mitotic Activity: The presence of mitotic activity, or dividing tumor cells, can be indicative of a higher-grade meningioma. A higher mitotic index is associated with increased cell proliferation and potentially more aggressive tumor behavior.

Brain Invasion: In some cases, meningiomas may invade the surrounding brain tissue, making complete surgical resection more challenging. The invasion of tumor cells into the brain parenchyma is associated with a higher likelihood of tumor recurrence.

Molecular genetics: Recent studies have identified specific genetic and molecular alterations in meningiomas, including mutations in the NF2 gene, which is involved in regulating cell growth and division. Other genetic changes, such as mutations in the TRAF7 and KLF4 genes, have also been

associated with different meningioma subtypes.

Histopathology

- Required for definitive diagnosis.
- WHO grading system (2021):
  - **Grade 1:** Benign (e.g. meningothelial, fibrous)
  - **Grade 2:** Atypical
  - **Grade 3:** Anaplastic (malignant)
- **Immunohistochemical markers:**
  - **EMA+ (epithelial membrane antigen)**
  - **PR+ (progesterone receptor)** – often in Grade 1
  - **Ki-67 (MIB-1):** Proliferation index for grading
  - **Merlin (NF2):** Loss may correlate with NF2 mutation

Molecular Diagnostics

- **NF2 gene mutations:** Common in sporadic meningiomas
- **Chromosome 22q deletions**
- **TERT promoter mutations** – linked to aggressive behavior
- **DNA methylation profiling:** Emerging tool for prognosis

Merlin Immunohistochemistry for Meningioma Diagnosis

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Genomics

Meningioma gene mutations

1)
Behling F, Bruneau M, Honegger J, Berhouma M, Jouanneau E, Cavallo L, Cornelius JF, Messerer M, Daniel RT, Froelich S, Mazzatenta D, Meling T, Paraskevopoulos D, Roche PH, Schroeder HWS, Zazpe I, Voormolen E, Visocchi M, Kasper E, Schittenhelm J, Tatagiba M. Differences in intraoperative sampling during meningioma surgery regarding CNS invasion - Results of a survey on behalf of the EANS skull base section. Brain Spine. 2023 Apr 11;3:101740. doi: 10.1016/j.bas.2023.101740. PMID: 37383436; PMCID: PMC10293290.
2)
Dal Col P, Garaix T, Massard A, Vassal F, Rivoirard R, Dumollard JM, Barral-Clavel F, Boutet C, Ramirez C, Péoc'h M, Forest F. Meningioma sampling: how much is enough for the accurate grading of atypical meningiomas? Pathology. 2021 Aug;53(5):602-607. doi: 10.1016/j.pathol.2020.10.024. Epub 2021 Feb 20. PMID: 33618862.