Adamantinomatous craniopharyngioma diagnosis

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see also Craniopharyngioma diagnosis.

Diagnosis of adamantinomatous craniopharyngioma (ACP) is predominantly determined through invasive pathological examination of a neurosurgical biopsy specimen.

▷ ESSENTIAL ◁

Tumor in the sellar region

Squamous non-keratinizing epithelium, benign

AND

stellate reticulum and/or wet keratin

▷ DESIRABLE ◁

▶ Nuclear immunoreactivity for β-catenin

▶ Mutation in CTNNB1

▶ Absence of BRAF p.V600E mutation

Adamantinomatous craniopharyngiomas typically have a lobulated contour as a result of usually being multiple cystic lesions. Solid components are present, but often form a relatively minor part of the mass and enhance vividly on both CT and MRI. Overall, calcification is very common, but this is only true of the adamantinomatous subtype (~90% are calcified).

These tumors have a predilection to being large, extending superiorly into the third ventricle, encasing vessels, and even adhering to adjacent structures.

Computed tomography

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Contrast enhancement, cyst formation, and calcification are the three characteristic features of craniopharyngiomas on computed tomography. More than 90% of suprasellar craniopharyngiomas exhibit at least two of these three features, thus providing easy radiologic detection. Imaging mnemonic: “90% rule” 90% of adamantinomatous craniopharyngiomas exhibit at least 2 of the following “C” features: cyst formation, prominent calcifications. [1)]

Magnetic resonance imaging

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Meta-Analysis on Diagnosis, Segmentation, and Classification

Cysts

T1: iso- to hyperintense to the brain (due to high protein content “motor oil cysts”)

T2: variable but ~80% are mostly or partly T2 hyperintense

Solid component

T1 C+ (Gd): vivid enhancement

T2: variable or mixed

Calcification

Difficult to appreciate on conventional imaging

Susceptible sequences may better demonstrate calcification

MR angiography

May show displacement of the A1 segment of the anterior cerebral artery (ACA)

MR spectroscopy

Cyst contents may show a broad lipid spectrum, with an otherwise flat baseline.

Clinical experts can distinguish ACP from Magnetic Resonance Imaging (MRI) with an accuracy of 86%, and 9% of ACP cases are diagnosed this way. Classification using deep learning (DL) provides a solution to support a non-invasive diagnosis of ACP through neuroimaging, but it is still limited in implementation, a major reason being the lack of predictive uncertainty representation. We trained and tested a DL classifier on preoperative MRI from 86 suprasellar tumor patients across multiple institutions. We then applied a Bayesian DL approach to calibrate our previously published ACP classifier, extending beyond point-estimate predictions to predictive distributions. Our original classifier outperforms random forest and XGBoost models in classifying ACP. The calibrated classifier underperformed our previously published results, indicating that the original model was overfitting. The mean values of the predictive distributions were not informative regarding model uncertainty. However, the variance of predictive distributions was indicative of predictive uncertainty. We developed an algorithm to incorporate predicted values and the associated uncertainty to create a classification abstention mechanism. Our model accuracy improved from 80.8% to 95.5%, with a 34.2% abstention rate. We demonstrated that calibration of DL models can be used to estimate predictive uncertainty, which may enable the clinical translation of artificial intelligence to support the

non-invasive diagnosis of brain tumors in the future [2].

1)

Johnson LN, Hepler RS, Yee RD, Frazee JG, Simons KB. Magnetic resonance imaging of craniopharyngioma. Am J Ophthalmol. 1986 Aug 15;102(2):242-4. doi: 10.1016/0002-9394(86)90152-2. PMID: 3740186.

2)

Prince EW, Ghosh D, Görg C, Hankinson TC. Uncertainty-Aware Deep Learning Classification of Adamantinomatous Craniopharyngioma from Preoperative MRI. Diagnostics (Basel). 2023 Mar 16;13(6):1132. doi: 10.3390/diagnostics13061132. PMID: 36980440; PMCID: PMC10047069.