International Journal of Surgery 36 (2016) 109–117

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.journal-surgery.net

Original research

Accuracy of conventional MRI for preoperative diagnosis of intracranial tumors: A retrospective cohort study of 762 cases

Peng-Fei Yan [a, 1], Ling Yan [b, 1], Zhen Zhang [c], Adnan Salim [d], Lei Wang [a], Ting-Ting Hu [a], Hong-Yang Zhao [a, *]

[a] Department of Neurosurgery, Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, Hubei, 430022, China
[b] Department of Medicine, University of British Columbia, Vancouver, BC, V6T 1Z3, Canada
[c] Department of Radiology, Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, Hubei, 430022, China
[d] Civil Hospital Karachi, Karachi, 74200, Pakistan

HIGHLIGHTS

- The most common tumors were meningioma, glioma, pituitary adenoma and schwannoma.
- The overall diagnostic sensitivity and PPV were 72.0–90.7% and 91.9–95.4%.
- Diagnostic accuracy differed among tumor types.
- Some tumor types tended to be confused with each other.
- Preoperative MRI reports should not be relied upon too heavily in decision-making.

ARTICLE INFO

Article history:
Received 16 July 2016
Received in revised form
30 September 2016
Accepted 15 October 2016
Available online 20 October 2016

Keywords:
Diagnostic accuracy
Intracranial tumor
Magnetic resonance imaging
Neurosurgery
Preoperative diagnosis

ABSTRACT

Background: Conventional magnetic resonance imaging (MRI) is considered a valuable tool for preoperative diagnosis of intracranial tumors. We assessed its accuracy in the diagnosis of intracranial tumors in usual clinical practice.

Materials and methods: MRI reports of 762 patients who had undergone conventional brain MRI prior to surgery were retrospectively reviewed. A 4-grade scoring system was devised to establish diagnostic agreement. Each tumor type was compared with the corresponding pathological diagnoses by dichotomization. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy were calculated for the overall patient population as well as for each tumor type.

Results: 664 cases (87.1%) were tumor-positive, and 98 cases (12.9%) were tumor-negative. The most common tumor types were meningiomas, gliomas, pituitary adenomas and schwannomas. These four types together comprised 74.5% of all cases reviewed. Sensitivity and PPV for the overall population were 72.0–90.7% and 91.9–95.4%, respectively. Diagnostic accuracy differed among tumor types. Meningiomas, pituitary adenomas, schwannomas and cholesteatomas were more likely to be diagnosed correctly (sensitivities were 82.6–96.9%, 86.1–96.7%, 88.9–98.2% and 91.3–100.0%, respectively); while some other types like solitary fibrous tumors (SFTs) seemed difficult to identify. Gliomas tended to be confused with metastases, meningiomas with SFTs, and pituitary adenomas with craniopharyngiomas.

Conclusion: The accuracy of conventional MRI for diagnosing intracranial tumors is generally satisfactory but should not be too heavily relied upon, especially for certain tumor types. In cases of discrepancy, neurosurgeons are encouraged to confer with the reporting neuroradiologists to achieve optimal preoperative diagnoses.

* Corresponding author. Department of Neurosurgery, Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, 1277 Jiefang Avenue, Wuhan, China.
E-mail addresses: yanpfei@hust.edu.cn (P.-F. Yan), ling.yan@alumni.ubc.ca (L. Yan), zhenzhang_zz@yahoo.com (Z. Zhang), adnansalim7@outlook.com (A. Salim), wanglei8129@gmail.com (L. Wang), hu_tingting@hotmail.com (T.-T. Hu), hongyang_zhao@hust.edu.cn (H.-Y. Zhao).
[1] These authors contributed equally to this work.

http://dx.doi.org/10.1016/j.ijsu.2016.10.023
1743-9191/

1. Introduction

Intracranial tumors are a public-health problem worldwide because of their increasing incidence in recent decades [1,2]. According to CBTRUS data, the overall incidence rate of intracranial tumors is 21.42 per 100,000 person-years; 7.25 per 100,000 person-years for malignant tumors, and 14.17 per 100,000 person-years for benign tumors [3,4].

An accurate preoperative diagnosis of tumor may be difficult to achieve, but it is always desirable for subsequent treatment planning and prognosis [5]. Radiological imaging is central in this respect [6]. Despite recent advances in radiological techniques, conventional magnetic resonance imaging (MRI) remains the standard of care for preoperative intracranial tumor diagnosis [2,7–10]. This is primarily due to many of its practical advantages, including wide availability, superior tissue contrast, absence of radiation, ability to image in multiple planes, and relatively few absolute contraindications [11]. MRI examinations can reveal a wide range of abnormalities, including intracranial neoplasms.

Clinicians routinely refer patients suspected of having intracranial tumors for MRI examinations. Radiologists interpret the scans and prepare formal reports to inform the referring clinicians of the findings. Clinicians then evaluate the conclusions of the reports, together with their own judgment, to decide on appropriate management plans. Radiologists' performance plays a key role in this process; correct interpretation can help avoid unnecessary surgical procedures and associated risks. Therefore, it is important to evaluate the validity of MRI image interpretations of intracranial tumors. Studies have been carried out to evaluate MRI's diagnostic accuracy in certain conditions, but to the best of our knowledge, limited data has been published on intracranial tumors [12–19]. In this study, we aim to assess the diagnostic accuracy of preoperative MRI for intracranial tumors in usual clinical practice, using pathological results as the reference standard.

2. Material and methods

2.1. Patient population

In order to reduce potential bias, we designed the study in accordance with the Standards for the Reporting of Diagnostic Accuracy Studies (STARD) criteria [20]. All clinical data for the study was collected from our institution, a university-affiliated hospital. Our institutional review board approved this study and waived the requirement for informed consent. We retrospectively searched the surgical database of neurosurgery department for the records of patients who underwent surgery between January 2012 and October 2015, preceded by conventional brain MRI performed at our institution. This query returned 847 patients. From this group, we excluded patients with history of previous intracranial surgeries, radiotherapies, or injuries, and patients with incomplete postoperative pathology data. A flow diagram illustrates the enrollment process in Fig. 1. A total of 762 patients met these criteria and comprised the study group.

2.2. Pathological findings

Pathology specimens were obtained by surgical resections, and then analyzed by expert pathologists provided with clinically suspected diagnoses. Patients diagnosed with intracranial tumors by pathology were classified as tumor-positive, the others were classified as tumor-negative. Pathological diagnoses for tumor-negative patients include arachnoid cyst, Rathke's cyst, vascular malformation, aneurysm, angiocavernoma, brain abscess, demyelinating pseudotumor, gliosis, infarction, and negative finding (i.e., no specific pathological findings were observed). Based on histopathological findings, tumor-positive patients were further categorized into the following groups: meningioma, glioma, pituitary adenoma, schwannoma, cholesteatoma, craniopharyngioma, metastasis, hemangioblastoma, lymphoma, solitary fibrous tumor (SFT), primitive neuroectodermal tumor (PNET), choroid plexus papilloma (CPP), germ cell tumor (GCT), chordoma, and central neurocytoma (CNC). Each type included its corresponding subtypes. For example, meningiomas included subtypes like transitional, fibrous, meningothelial, angioblastic, psammomatous and atypical meningiomas; while pituitary adenomas included subtypes like PRL-secreting, ACTH-secreting, GH-secreting, TSH-secreting, and mixed adenomas. Schwannomas consisted of 52 cases of acoustic schwannomas, 1 case of trigeminal schwannoma, and 1 case of glossopharyngeal schwannoma. Gliomas consisted of astrocytomas (n = 101), oligodendrogliomas (n = 18), ependymomas (n = 7), gangliogliomas (n = 5), and dysembryoplastic neuroepithelial tumors (DNT, n = 3). Tumor grade was not considered in the categorization process.

2.3. Review of MRI examinations

As this study aimed to evaluate MRI's accuracy in usual clinical care, we reviewed MRI reports to determine neuroradiologists' interpretation of MRI scans with regard to the presence and types of tumors—rather than re-interpreting the actual scans. Scans were obtained using an 8-channel radiofrequency coil with one of the two machines: Siemens Magnetom Avanto 1.5-T (276 patients), and Siemens Magnetom Verio 3.0-T (486 patients). The standard imaging protocol consisted of multi-planar dual FSE proton attenuation T1WI (TR/TE, 500/8.4 ms), T2WI (TR/TE, 9000/89 ms), Fluid-attenuated Inversion Recovery (FLAIR, TR/TE, 9000/105 ms); and gradient echo sequence T1WI (TR/TE, 300/2.46 ms), T2WI (TR/TE, 4200/96 ms), T2WI-Tirm-Dark-Fluid (TR/TE, 9000/90 ms). DWI was obtained in all patients with diffusion sensitivity (b-values) of 0 and 1000 s/mm^2. All sequences were obtained with a 230 mm field of view, 90° flip angle and an interpolated 256 × 256 matrix. Slice thicknesses were 5 mm for axial images and 6 mm for sagittal images. Sagittal and axial T1WI views were also obtained after a single dose of an intravenous bolus of 0.2 ml/kg of gadolinium DTPA. Images were stored in Picture Archiving and Communication Systems (PACS) and could be remotely accessed. According to our radiology department policy, every examination was first read by a junior neuroradiologist and then re-examined by an expert neuroradiologist with more than ten years of experience (both were blinded to pertinent clinical information); in cases of discrepancy, consensus was achieved through discussion. Formal reports were provided in both paper and electronic forms to the referring clinicians.

Compared with the reference standard, each MRI report was reviewed and assessed. Two authors (a neurosurgery faculty member [PFY], and a radiology faculty member [ZZ]) participated in this process. Firstly, each MRI report was categorized from A to D. Category A consisted of cases where only one definite MRI diagnosis was provided. In cases where more than one diagnosis were provided, if one of these diagnoses was indicated as primary, this report was categorized as B; if no primary diagnosis was indicated, that report was categorized as C. In some reports, the diagnosis was vaguely reported as “intracranial tumor” or “brain tumor”, with no specific tumor types mentioned; cases of this kind were categorized as D.

When measuring test performance for specific tumor types, MRI reports were graded on a scale ranging from 0 to 4 (0 = disagree, 1 = indeterminate or equivocal, 2 = slightly agree, 3 = agree, 4 = strongly agree). If the report was previously classified as