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Is it possible to presume primary cancer sites of origin on the basis of MRI pattern of intraaxial posterior fossa metastatic tumors

ABSTRACT

Background: *Purpose of the study was to determine whether the native and contrast enhanced MRI pattern of detected intraaxial posterior fossa metastatic tumors may potentially suggest the origin of primary malignoma.*

Materials and methods: *In 99 patients with known primary cancer, in whom non-contrast MRI brain examination on 1.5T MRI unit (Siemens Magnetom SP 63-4000) revealed tumorous lesion localized in posterior fossa using the routine protocol, paramagnetic contrast agent (Gadolinium-DTPA) was applied intravenously. After the application of the contrast agent we performed contrast-enhanced T1W scans in at least two optional planes (transversal and saggital or coronal).*

Results: *In great majority of the patients, MRI pattern of intraaxial posterior fossa metastatic tumors was nonspecific. In 9 patients (9.09%) specific pattern was connectable with the primary malignoma site of origin. In 29 patients more (29.29%) MRI examination revealed additional data which in future patients may give a clue for further diagnostic test in revealing the primary cancer site of origine.*

Conclusion: *Regardless its primary site of origin, great majority of intraaxial metastatic tumors in posterior fossa demonstrate nonspecific MRI pattern, while only small number of metastases, due to their unique features, demonstrate specific pattern which may suggest the primary malignancy site of origin.*

Key words: *Posterior fossa, Metastasis, Magnetic resonance imaging, Gadolinium-DTPA*

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INTRODUCTION

Metastatic spread of malignant tumor to the brain and its coverings from extracranial sites is a relatively common occurrence which represents a frustrating therapeutical problem for a physician (1). That feature is aggravated with the fact that in adult population intracranial metastases usually account for between one-quarter and one third of all brain tumors (2,3), and they may occur in patients of all ages, although the highest incidence is in patients in the fourth to seventh decade of life (3).

On the other hand, although the brain metastases are likely to coexist with other sites of metastatic disease, the symptoms from brain metastases tend to antedate the primary diagnosis of cancer in over 45% of cases (4).

Approximation from literature reports concerning the incidence of metastases localized in posterior fossa range from 3-10% of all new detected intracranial neoplasms, and roughly 15-20% of all intracranial metastatic tumors (5).

The neuroanatomic localization of the metastasis and its associated edema and mass effect usually determine the nature of the clinical presentation (6). Generally, signs and symptoms of metastatic disease in the posterior fossa are dependent on two basic pathological features:

a) increased intracranial pressure, due to compressive or infiltrative obstruction of CSF pathways causing internal hydrocephalus, and represent a non-specific neurological symptom, and

b) tumorous infiltration of local neuroanatomical structures, which may express itself with more specified neurological signs (7).

Still, the most common symptoms that should lead clinician to the suspicion of existing posterior fossa brain metastasis include headaches, confusion, visual problems, vertigo, vomiting and aphasia (7), but unfortunately, clinically silent lesions are not uncommon (6).

Therefore, the role of radiologist in the search for intracranial metastatic tumors is important, and lies in detecting the lesions, determining their localization and making the specific diagnosis of metastases (8). Choosing the most effective diagnostic imaging method is, therefore, of undoubted importance for the radiologist, in order to shorten the valuable time between establishing the diagnosis and therapy start in the first place and to cut the health care costs by minimizing the number of diagnostic procedures needed for setting the correct diagnosis (9).

Having in mind that CT images are invariable degraded by streaking artifacts from the bones at the skull base, MRI is much preferable to CT for evaluation of posterior fossa region, not only because of its ability to display anatomy and any pathological changes with a definition incomparable by any other imaging techniques and almost artefact-free, but also because of MRI's multiplanar capabilities, high sensitivity for early detection of discrete pathological changes and very good soft tissue differentiation, which gives an excellent boundary contrast between pathological and anatomical structures with unprecedented clarity (10).

Even with modern imaging techniques like

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MRI, a diagnostic problem how to determine the site of origin of the primary tumor only on the basis of diagnosed metastatic tumors MRI pattern remains. Presuming that some brain metastases originating from different cancers may probably have a different MRI presentation, we tried to determine the native and contrast enhanced MRI pattern of detected intraaxial posterior fossa metastatic tumors in patients with primary malignomas of various origin.

MATERIALS AND METHODS

In 99 patients (46 male, 53 female, age range from 45 to 76, average age 56.23 years) with known primary cancer, in whom non-contrast MRI brain examination on 1.5T MRI unit (Siemens Magnetom SP 63-4000) revealed tumorous lesion or lesions localized in posterior fossa using the routine protocol consisted of:

- Gradient Recalled Echo (GRE) T1-weighted (W) sequence in sagital plane instead of scout view (TR 270ms, TE 6ms, section thickness 5mm, FOV 250mm, Matrix 192x256, NEX 1);
- Turbo Spin Echo (TSE) T2W/PD in transversal plane (TR 4000 msec, TE 93/19 msec, section thickness 5-6 mm, FOV 250mm, Matrix 192x256, NEX 3);
- GRE T1W in coronal plane on region of interest: (TR 270ms, TE 6ms, slice thickness 4-5 mm, FOV 250 mm, Matrix 192x256, NEX 2);

we performed contrast-enhanced T1W scans in at least two optional planes (transversal and sagital and/or coronal), three to five minutes after the intravenous administration of paramagnetic contrast agent (Gadolinium-DTPA) in concentration of 0.1 mmol/kg BW.

RESULTS

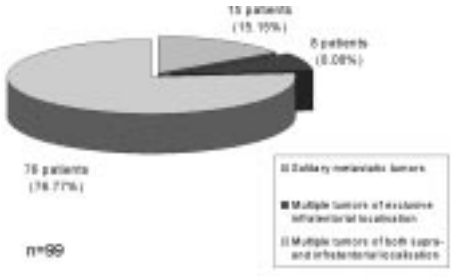
Summarized results of the study are presented in Table 1.

Table 1. Distribution of intraaxial posterior fossa metastasis according to primary malignancy origin and their predominant MR characteristics on native and contrast enhanced sequences.

Origin of primary malignancy in patients with detected posterior fossa metastasis	Patients Nr. %	Signal intensity		
		T1W	T2W	T2W
Breast	36 (36.36)	↓ to ↓↑	↓↑ do ↑↑	↑↑to↑↑↑ solid or rim
Lungs	33 (33.33)	↓ to ↓↑	↓↑ do ↑↑	↑to↑↑↑, solid or rim, rarely patchy
Colorectal	10 (10.10)	↓ to ↓↑	↓↓ to ↑↑	↑↑to↑↑↑ solid or rim
Malignant melanoma	8 (8.08)	↑ to ↑↑↑ in melanotic, otherwise to	↓↑ to ↑↑ in both melanotic and non-melanotic	not observable in melanotic, otherwise ↓↑to ↑↑↑
Kidney	5 (5.05)	↓ to ↓↑	↓↑ to ↑↑	↑↑to↑↑↑ solid or rim
Testis	3 (3.03)	↓ to ↓↑	↓↑ to ↑↑	↑↑to↑↑↑ solid or rim
Oesophagus	2 (2.02)	↓ to ↓↑	↓↑ to ↑↑	↑↑to↑↑↑ solid or rim
Ovarium	1 (1.01)	↓ to ↓↑	↓↑ to ↑↑	↑↑to↑↑↑ solid or rim
Choriocarcinoma	1 (1.01)	Hemorrhagic, inhomogeneusly ↓ to ↓↑	Hemorrhagic, inhomogeneusly ↓ to ↓↑	Iregular, patchy ↑↑to↑↑↑
Total	99 (100)			

Legend: ↑-mildly increasd signal intensity (SI), ↓-mildly decreased SI, ↓↑-intermediate SI, ↑↑-moderately increased SI, ↓↓-moderately decreased SI, ↑↑↑-extremely increased SI, ↓↓↓-extremely increased SI, — -no changes in SI, CE T1W-contrast enhanced T1W scans

In 84 patients (84.85%) the tumors were multiple, and in only 15 patients (15.15%) they



Graph 1. Distribution of the posterior fossa etastatic tumors according to the number of lesions

appeared as solitary lesions. The distribution of multiple and solitary metastatic tumors is presented on Figure 1.

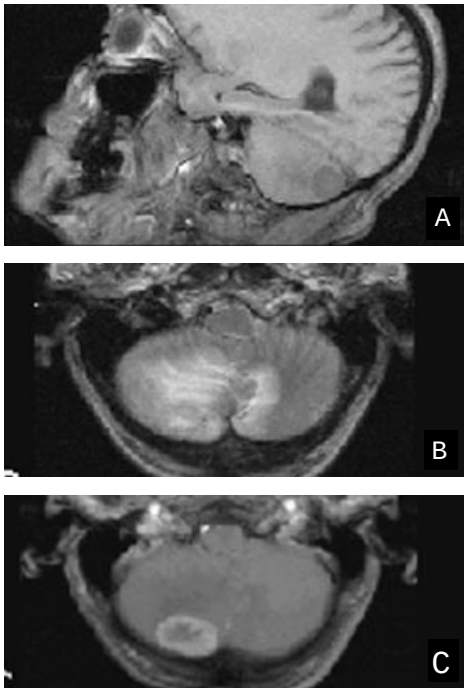


Figure 1. A. T1W sagital, B. T2W axial and C. CE T1W axial scans. Tipical MR features of intraaxial metastatic tumor surrounded by a massive perifocal edema with prominent contrast enhancement. Central area without SI changes on CE T1W sequence corresponds to the necrotic intratumorous portion.

Great majority of the detected intraaxial

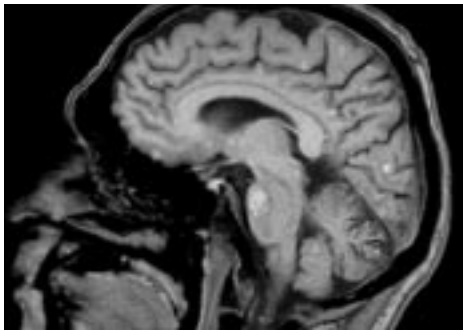


Figure 2. Non-CE T1W sagital image in patient with malignant melanoma metastasis. Multiple diffusely distributed small tumorous foci of high signal intensity are evident in cerebellum and brainstem, but also and supratentorial.

metastases, regardless the site of origin, are presented as round-shaped nodules of different size, mildly hipointense to izointense on T1W images, izointense to moderately hyperintense on T2W images, with mandatory contrast uptake in a form of a solid or rim enhancement (Figure 2).

Different pattern was observable in 5 of 8 patients (62.5%) with multiple melanoma metastases, in whom the tumors showed high signal intensity on non-contrast T1W images (Figure 3) and in 4 of 10 patients (40%) with colorectal carcinoma metastases, presented with markedly low signal intensity on T2W images (Figure 4).

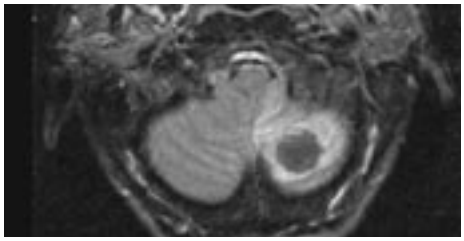


Figure 3. T2W axial image in patient with solitary metastatic tumor originatig from colorectal carcinoma in left cerebellar hemisphere. Markedly hypointensity of the tumorous mass is evident, standing out from surrounding hyperintense edema.

Presence of perifocal edema as a surrounding area of poorly demarkated hypointensity on

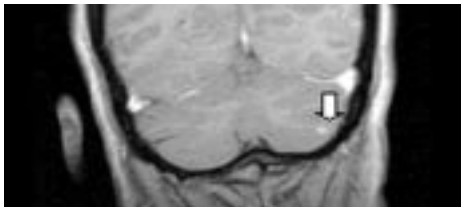


Figure 4. CE T1W sequence in coronal plane. Small metastatic focus (white arrow) became visible only after the administration of paramagnetic contrast agent in lack of perifocal edema

T1W sequence, hyperintensity on T2W sequence without any signal intensity alteration after contrast administration was detected in 87 patients (87.88%) with intraaxial metastatic tumors. In 12 patients (12.12%) with metastatic lesions of small diameter perifocal edema was not found (Figure 5).

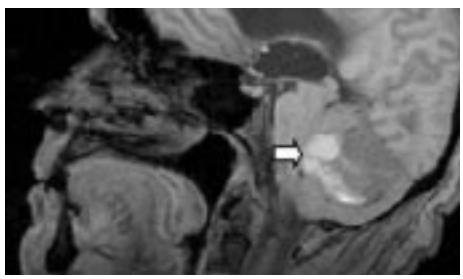
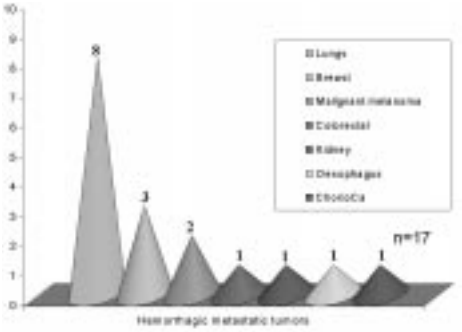


Figure 5. Intratumorous areas of hyperintensity (arrow) on non-CE T1W sagital scan in patient with bronchogenic carcinoma metastasis indicates the regions of hemorrhage.



Graph 2 . Frequency of hemorrhagic intraaxial metastatic tumors according to primary malignancy origin.

Intratumorous hemorrhage was detected in 17 (17.17%) patients with posterior fossa intraaxial metastatic tumors. Hemorrhagic component was usually visible as area of high T1W signal intensity (Figure 6) and low T2W signal intensity.

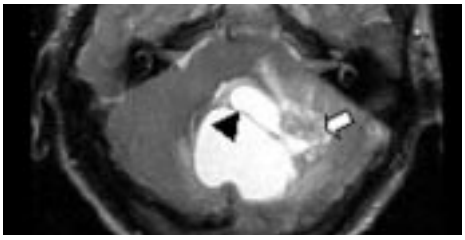
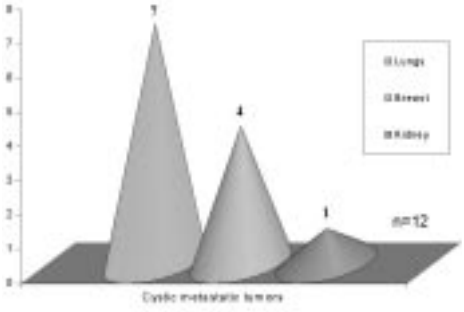


Figure 6. T2W axial scan in patient with cystic small-cell bronchial carcinoma metastasis in midcerebellum. cystic component is presented as an area of hyoerintensity with septation (black arrowhead), giving a good contrast to the solid tumorous portion of intermediate signal intensity (white arrow).

The frequency of hemorragic metastatic tumors was shown on Figure 7.



Graph 3. Frequency of cystic intraaxial metastatic tumors according to primary malignancy origin.

Cystic metastatic tumors were found in 12 (12.12%) patients. Typical MR appearance of cystic intraaxial metastatic tumors is presented on Figure 8, while the sites of origin of the primary malignancies in those patients are shown on Figure 9.

DISCUSSION

Intraparenchymal metastatic tumors are the most common type of metastatic disease to affect the cranial space. Although the data varies amongst different reported series the results of our study correlate with majority of previous reports with breast and lungs as the posterior fossa metastatic tumors of highest frequency, followed by colorectal carcinoma and malignant melanoma, renal cell carcinoma and others (6). The brain is often the only site of metastases in patients with extracranial malignancy, especially in those with bronchogenic carcinoma and melanoma (11).

Regardless the site of origin, in the great majority of patients metastatic tumors are multiple, most commonly involving both supra- and infratentorial compartement and much less frequent infratentorial only. Still, the incidence of solitary metastases in our study accounts only about one-fourth of cases, which is approximately twice less than in results of some other published studies (6,11). Yet, the fact that an intraaxial tumorous lesion is solitary does not exclude the consideration of metastasis as a diagnosis in a first place (12). Since the differentiation between solitary and multiple metastases radically changes the therapeutical treatment (surgery in solitary instead of radiotherapy in multiple lesions), the accurate detection of all present metastatic tumors is critical to patients management.

Although the metastatic tumors are surrounded by massive perifocal edema of vasogenic origin in great majority of cases, the absence of edema does not exclude the presence of small, hard distinguishable tumorous lesions. Therefore, the administration of the paramagnetic contrast agent is obligatory in all patients with suspected metastatic disease in posterior fossa. In order to shorten the examination time, for screening the patients with suspected posterior fossa metastasis, we may suggest performing of the contrast enhanced images only (13), immediately after the orientational T1W sagital scans.

The MRI appearance of the most metastases on non-contrast, but also contrast-enhanced scans is unfortunately nonspecific (14). Great majority of metastatic tumors in posterior fossa presents with lower to intermediate signal intensity on T1W images, intermediate to high signal on T2W images with almost mandatory solid or rim contrast enhancement. If present, rim uptake may differ from uptake of some other disease states such as abscesses or demyelinating plaques by its wall characteristics (12). Our results suggests that the presence of thick, irregular or nodular enhancement could suggest, but it is not to be considered as an accurate sign of malignant lesion.

On the other hand, exceptions to presented nonspecific MRI characteristics of metastasis are demonstrated by malignant melanoma metastasis and colorectal adenocarcinoma metastasis. Specificity of the MRI in detecting the nonhemorrhagic melanotic metastasis comes from its hyperintensity on non-CE T1W images due to the paramagnetic effect of melanine which is ascribed to its free radical content (15). Characteristic T2W hipointensity of colorectal adenocarcinoma metastasis is still of unexplained ethiology, but if present that pattern may be an inicial clue for determinig its site of origin (16,17).

The presence of intratumorous hemorrhage which occurs in just under one-fifth of all posterior fossa metastases, based on our results appears to be the most common in lung carcinoma metastasis, as well as the cystic intratumorous pattern. Still there are other metastases with previously verified tendency to bleed, among them choriocarcinoma metastases, melanoma and renal cell carcinoma metastases (18).

CONCLUSION

1. Regardless its primary site of origin, great majority of intraaxial metastatic tumors in posterior fossa demonstrate nonspecific native and contrast-enhanced MRI pattern; therefore it wouldn't be possible to determine the site of origin of the primary cancer on the basis of diagnosed metastatic tumors MRI pattern.

2. Still, some metastatic tumors, such as malignant melanoma and colorectal adenocarcinoma metastases, due to their unique features, demonstrate specific MRI pattern which may suggest the primary malignancy site of origin.

3. Intratumoral hemorrage or cystic appearance may provide a more defined clue in further diagnostic search for primary cancer.

4. The administration of paramagnetic contrast agent (Gadolinium-DTPA) is mandatory not only for better depiction and delineation of metastasis, but also for detecting possible small tumorous lesions in patients with negative non-contrast MRI images.

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