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MRI CHARACTERISTICS OF ATYPICALLY WIDE PERIVASCULAR SPACES

Case Report

ATİPİK GENİŞ PERİVASKÜLER ALANLARIN MRI KARAKTERİSTİKLERİ

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ABSTRACT

Objective

The aim of this study was to reveal the magnetic resonance imaging (MRI) characteristics of perivascular spaces (PVSs) that help to differentiate them from other various intracranial cystic pathologies.

Materıal And Method

From the archieves, retrospectively, a total of 11 cases with the complaints of headache, recent development of cognitive impairment and recent onset epilepsy whose radiological reports revealed atypically wide PVSs were included in this study (M:8, F:3, mean age: 44 years). PVSs were accepted as atypical when the diameter exceeded 1 cm or <1cm lesion had tendency towards confluence.

Results

The dimensions of the lesions widened PVSs were in between 1 and 3,8 cm (mean 2,1 cm). In most of the cases, the lesions were located in left cerebral hemisphere and deep white matter of the occipital lobe. In two patients, the lesions were dominantly located at the frontal lobes. While the lesions in occipital deep white matter had a tendency towards confluence, lesions at the frontal lobe were rested separately. In only one case, which was evaluated for the new onset of epilepsy, the lesion caused a mass affect over hypocampus. In all the cases, enlarged PVSs were isointense with CSF and there was no restricted diffusion in neither of the cases. No contrast enhancement was seen in three cases for whom gadolinium was applied. All of the lesions were parallel to the trace of the main feding artery and on proton density images lesions were less hyperintense compared to the CSF.

Conclusıon

Wide PVSs should be evaluated for their localizations, the presence of space occupying or mass effects, contrast enhancement, association with arterial vasculature, and accompanying perilesional white matter signal intensity changes. Proton density sequences must be included in the evaluation for the characteristic signal loss compared to other T2 images.

Key words: *Virchow-Robin spaces; Brain; Magnetic Resonance Imaging*

Amaç

Bu çalışmanın amacı genişlemiş perivasküler boşlukların (PVB), manyetik rezonans görüntüleme (MRG) karakteristiklerini saptayarak diğer çeşitli kistik lezyonlardan ayırımını kolaylaştırmaktadır.

Materyal ve Metod

Arşiv bilgilerinden yola çıkarak, retrospektif olarak, başağrısı, son zamanlarda gelişen kognitif bozulma, yeni başlayan epilepsi nedeni ile başvurmuş ve radyoloji rapor bilgilerinde atipik olarak genişlemiş perivasküler boşluklardan bahsedilen 11 olguyu çalışmaya dahil ettik (E=8, K=3, ortalama yaş: 44 yıl). Bu çalışmada 1 cm'den daha geniş çaplı olan ve daha küçük çaplı olmalarına rağmen konfluens oluşturan PVB'lar atipik olarak adlandırıldı.

Bulgular

Genişlemiş PVB boyutları 1-3,8 cm arasında değişmekte idi (ortalama 2,1 cm).Olgularda ağırlıklı olarak sol hemisfer ve derin sol oksipital alanlar etkilenmiş iken, iki olguda belirgin frontal lob tercihi dikkati çekmekte idi. Lezyonlardan oksipital bölgede olanlar daha çok konfluent olma eğiliminde iken, frontal lobda bulunanlar dağınık konfigürasyonda idi. Yeni başlayan epilepsi nedeni ile değerlendirilen bir olguda lezyon hipokampus üzerinde kitle etkisi oluşturmakta idi. Herhangi bir lezyonda difüzyon kısıtlılığı gelişmemiştir ve MRG'de PVB genişlemeleri beyin omurilik sıvısı ile izointens karakterde davranmıştır. Kontrast madde kullanılmış olan 3 olgunun herhangi birisinnde patolojik kontrast tutulumu tespit edilmemiştir. Tüm lezyonlar zemindeki ana arterial besleyici sistemin trasesine paralel yerleşmiş ve proton dansite ağırlıklı serilerde, karakteristik olarak beyin omurilik sıvısına göre daha az parlamakta idiler.

Sonuç

Geniş PVB'lar radyolojik olarak değerlendirilirken; lokalizasyonları, yer kaplayıcı etki oluşturup oluşturmadıkları, kontrastlanma durumları ve besleyici arterlere göre konfigürasyonları, çevreleyen beyaz cevherde anormal sinyal kaydı ile birlikte olup olmadıkları belirtilmeli; özellikle proton ağırlıklı seriler ile birlikte incelenmeli ve diğer T2 ağırlıklı sekanslara göre bu sekansta karakteristik sinyal düşüşü gösterip göstermedikleri araştırılmalıdır.

Anahtar Kelimeler: *Virchow-Robin boşlukları; beyin; Manyetik rezonans görüntüleme* .

INTRODUCTION

The brain perivascular spaces (PVSs) are pial-lined, interstitial fluid-filled structures that accompany penetrating arteries. Even in the normal brain, some Virchow-Robin spaces (VRSs) are usually seen in the area of the substantia innominata at the level of the anterior commissure, and a small number of dilated spaces may also be seen at the basal ganglia (BG) in up to 60% of individuals. When enlarged, they may cause mass effect and can be mistaken for more ominous pathologic processes (1-5). Many pathologic states result in abnormal dilatation of VRSs, with increased numbers of spaces visible on MR imaging (2, 3). These are seen particularly along the course of the penetrating striothalamic arteries in the BG, the external and extreme capsule and also along the course of penetrating

arteries in the centrum semiovale and the ventral mesencephalic tegmentum (5-9). The aim of this study was to reveal the MRI characteristics of perivascular spaces (PVSs) that help to differentiate them from other various intracranial cystic pathologies.

MATERIAL AND METHOD

We performed a retrospective review of 11 cases (male=8, female=3, mean age: 44 year) of giant PVSs referred for imaging at our institution over a 4-year period from 2005 to 2009 for the evaluation of nonspecific headache (n=8), early cognitive impairment (n=2), or new onset of epilepsy (n=1). All patients were examined with a 1.5T MR equipment (Siemens Vision Plus, Erlangen, Germany). Pulse sequences included T1-weighted spin-echo, T2-weighted fast spin-echo, proton density (PD), and fluid attenuated inversion recovery (FLAIR). Gadolinium-enhanced T1-weighted imaging was also performed in three of the patients. Wide PVS is defined as foci which are equal to or greater than 1cm in largest diameter, and they may occur as a solitary lesion or may be in the form of clusters containing multiple contiguous cysts. Widened and clustered PVSs which have subcentimetric diameters were also included (n=2).

Images were evaluated to determine the size of the giant PVSs, establish whether they were unilateral or bilateral, and ascertain whether the cysts were solitary or clustered. Images were also assessed for the appearance of associated focal or generalized mass effect, hydrocephalus, adjacent white matter changes, and presence of contrast enhancement. In our study another feature of the PVSs was also investigated which included comparison of the PD image characteristics with conventional FSE-T2 weighted image brightness. All the data for each of the lesions were recorded seperately, and distinguishing or prominent findings were noted which are explained under the guidance of figures.

RESULTS

The dimensions of the lesions were in the range of 1-3.8 centimeters. In six patients, the lesions were located at left cerebral hemisphere and occipital lobe deep white matter. In the rest five cases, they were located in the frontal lobes and centrum semiovale.

While the lesions in the occipital deep white matter had a tendency towards confluence, lesions found in frontal lobe were rested separately.

In only one patient, who was evaluated for the new onset of epilepsy, the lesion exerted mass effect over the hipocampus **(Figure 1).**

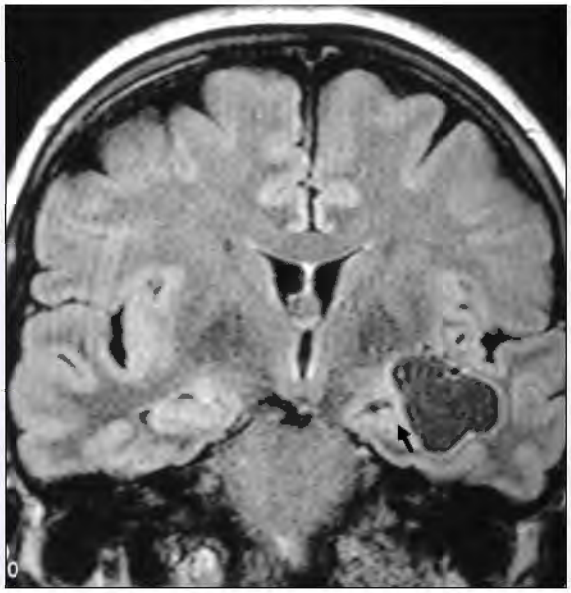

Figure 1. *Coronal FLAIR sequence; dilated giant PVS is seen which has generated a compression effect over the hipocampal region at the lateral side of the left temporal lobe.*

In all the patients, lesions were isointense with CSF **(Figure 2).**

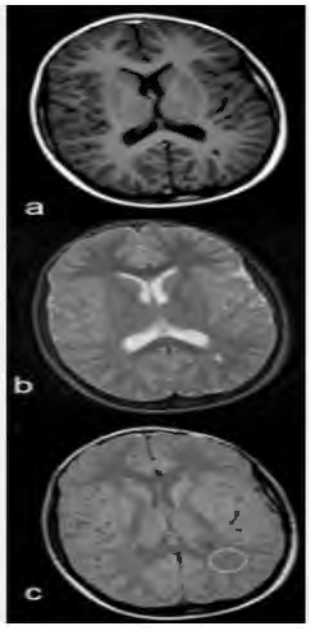

Figure 2. *A small caliber PVS located in the left occipital deep white matter. It is hypointense at T1W axial image (a), hyperintense at T2W axial image (b), but interestingly it is less conspicious at PDW axial images (encircled area in the c).*

and there were no restricted diffusion in neither of the cases **(Figure 3).**

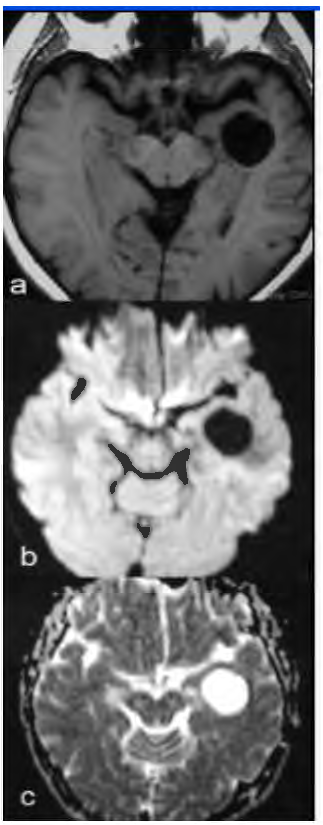

Figure 3. *Another dilated PVS located at the left subinsular region. T1W axial image (a), There is no diffusion restriction at the DWI (b=1000) image (b) or no restriction findings at the relevant ADC map image (c).*

But it was less conspicious signal intensity difference around the dilated PVSs on PDW images (Figure 2). There was no contrast enhancement in the lesions of three patients for whom gadolinium was applied **(Figure 4).**

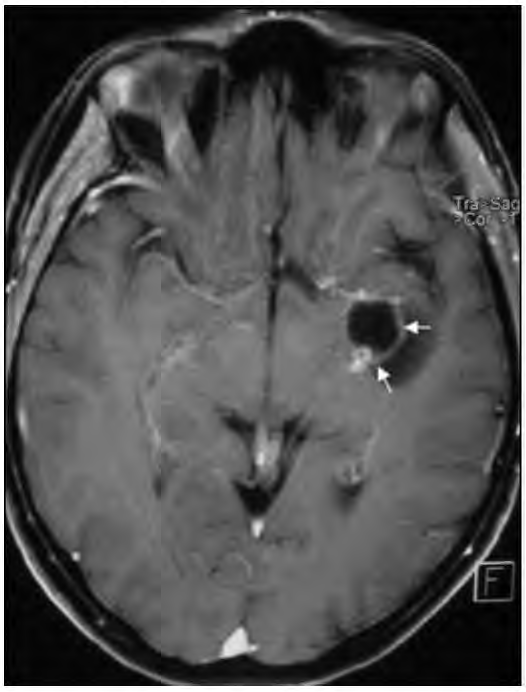

Figure 4. *Contrast enhanced T1W axial image of the Figure 3a shows the related artery is somewhat encircled by the dilated PVS.*

There were no intensity change in the vicinity white matter, but in frontal lobe of one patient, the white matter was minimally (suspected) hyperintense in T2 W and FLAIR sequences **(Figure 5).**

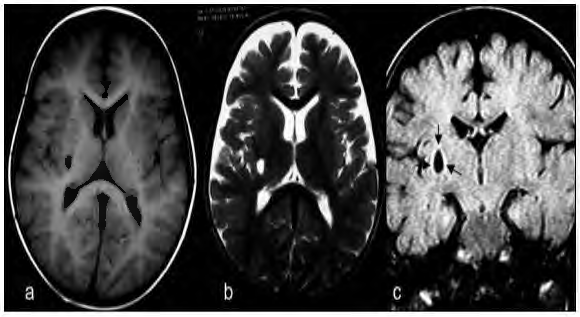

Figure 5. *A dilated PVS at the posterior limb of the right internal capsule. It is isointense at T1W image (a), hyperintense at T2W image (b). The lesion has peripheral high signal intensity rim at the FLAIR images.*

All the lesions were parallel to the traces of the vascular structures **(Figure 6).**

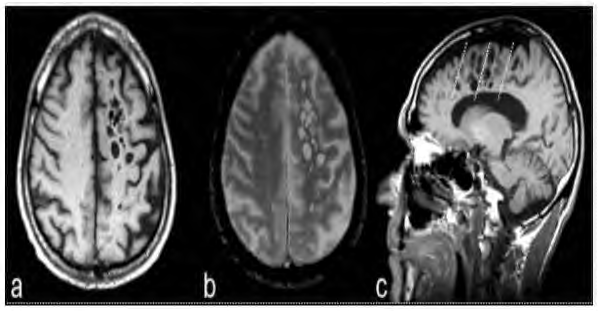

Figure 6. *Similar shaped PVSs located at the white matter of the left frontal hemisphere is seen at the T1W (a) and T2W (b) as isointense to CSF. At sagital T1W image, the elliptical PVSs are lined up parallel to the perforating vascular traces (c).*

In two cases, although there was co-existence of the scattered and confluent small PVSs **(Figure 7).**

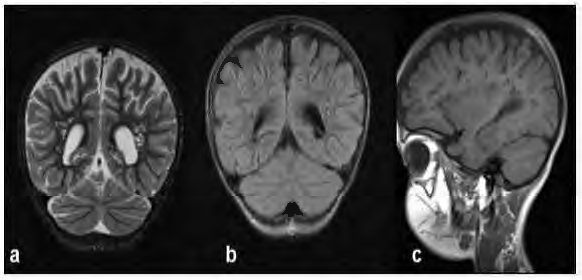

Figure 7. *MRI images of a patient whose clinical findings and urine metabolite levels are compatible with mucopolysaccharidosis. Multiple PVSs are seen which have a tendency towards confluence at the posterior periatrial area, and scattered seperately elsewhere.*

the exact pathology was approved as Hurler syndrome by the urine metabolite analysis
RESULTS.
In one patient who was reffered for the evaluation of cognitive disfunction, there were conspicious but very closely arranged PVSs throughout the white matter tracts of both hemispheres **(Figure 8).**

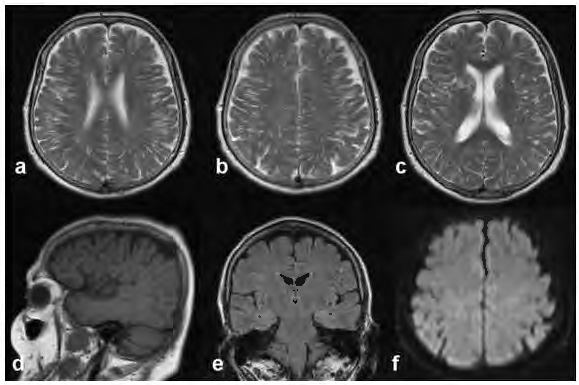

Figure 8. *MRI images of a 67 year old female patient with progressive cognitive dysfunction are shown. Atypical PVS enlargements are seen diffusely along all tracts, causing longitudinal enlargement rather thancystic expansion.*

DISCUSSION

VRSs are potential perivascular spaces covered by pia that accompany arteries and arterioles as they perforate the brain substance (10). Deep in the brain, the VRS are lined by the basement membrane of the glia limitans peripherally, while the outer surfaces of the blood vessels lie centrally (11). These pial layers form the VRSs as enclosed spaces filled with interstitial fluid and separate them from the surrounding brain and CSF (12). Several mechanisms for abnormal dilatation of VRSs have been suggested (12, 13). These include mechanical trauma due to CSF pulsation or vascular ectasia, fluid exudation due to abnormalities of the vessel wall permeability, and ischemic injury to perivascular tissue causing a secondary ex vacuo effect (12, 13).

Imaging features of enlarged PVSs are characteristic. On MRI, VRSs are round or curvilinear structures located around the path of the penetrating arteries. They are isointense to CSF on all pulse sequences and are usually smaller than 2–3 mm, even though they can be conspicuously dilated. FLAIR sequences typically show complete signal intensity suppression without associated abnormalities in the adjacent parenchyma (12, 14, 15). Despite the fact that perivascular spaces have MR signal intensity visually similar to CSF on all pulse sequences, the statistically significant difference between quantitative MR signal intensity values of the perivascular spaces and CSF, as revealed in this study, can reflect the presence of different contents within both spaces. This finding is compatible with the statement that the perivascular spaces

represent entrapments of interstitial fluid and are not the invagination of CSF-filled subarachnoid sheaths (16).

Dilated PVSs are mainly seen at two locations. The first is around the anterior commissure, conforming along the path of the lenticulostriate arteries entering the basal ganglia through the anterior perforated substance, whereas the second is the high cerebral convexities along the path of the perforating medullary arteries entering the cortical gray matter and extending into the white matter. The former is seen more frequently, and the latter is rather correlated with aging brain. When PVSs become markedly expanded, they can be misinterpreted as other pathologic processes, most often a cystic neoplasm (2, 3). When PVSs become enlarged, they are known as giant PVSs, "cavernous dilatation," or Poirier's Type IIIb "expanding lacunae" (3). As most of these cysts border a ventricle or subarachnoid space, reports of such cases have offered an extensive differential diagnosis that includes cystic neoplasms, parasitic cysts, ventricular diverticula, cystic infarction, non-neoplastic neuroepithelial cysts, and deposition disorders such as mucopolysaccharidosis (17-20).

Patients usually present with nonspecific findings that are not attributable to the giant PVSs (21, 22). In our series, headache was the most common presenting feature and occurred in approximately 70% of the patients. Other presenting complaints included dizziness, visual changes, seizure, syncope, memory problems, poor balance, and poor concentration. Several studies have shown that the clinical features of patients with this type of lesion do not correlate with the imaging findings or have been found incidentally at autopsy. However, widespread dilatation of the PVSs has been reported in association with dementia, migrain and parkinsonism (22, 23). Some authors have correlated large convexity and white matter PVSs with increasing age. Others have concluded that the prevalence of basal ganglia PVSs in patients younger than 40 years is not significantly different from that of older patients (23-30). We have observed prominent PVSs on high-spatial-resolution MR images in patients of all ages and in all typical anatomical locations. The clinical symptoms did not correlate with the giant PVSs in our series, except for the patient who had in the case that had associated epileptiform attacks.

CONCLUSION

Wide or giant tumefactive PVSs are interstitial-fluid filled structures that accompany arteries and arterioles as they penetrate the brain. They have characteristic imaging features: round or oval, single or multilocular lesions that are isointense relative to the CSF regardless of the imaging sequences and do not enhance. Appearences of the dilated PVSs are less conspicious at the PD weighted sequences. They may have associated symptoms (e.g. epilepsy, as in this study) that may require surgical intervention. Although they have associated mass effect, they should not be mistaken for neoplasm or other disease.

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