Ring-shaped Lateral Ventricular Nodules Detected with Brain MR Imaging

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Purpose: We evaluated the prevalence and imaging characteristics of ring-shaped lateral ventricular nodules (RSLVNs) detected by postcontrast brain magnetic resonance (MR) imaging.

Materials and Methods: We retrospectively reviewed cranial MR images of 1,241 patients who underwent contrast-enhanced brain imaging between January 1, 2008 and March 31, 2011, excluded images of inadequate quality of 130 patients, and ultimately analyzed images of 1,111 patients (544 male, 567 female). We assessed location, shape, and signal intensity of RSLVNs on T1-weighted (T1WIs), T2-weighted (T2WIs), fluid-attenuated inversion recovery (FLAIR), and diffusion-weighted (DWIs) images and characteristics of contrast enhancement.

Results: In 5 patients, we found 6 RSLVNs (0.45%), four in the frontal horn and two in the roof of the body. Three RSLVNs were round, two were oval, and one was lobular on axial images. All 6 RSLVNs were isointense with adjacent brain parenchyma on T1WI, T2WI, and DWI but slightly hyperintense on FLAIR images; none showed enhancement on postcontrast MR imaging. Five nodules serially examined (range, 8 to 24 months) showed no interval changes.

Conclusions: Our MR imaging findings of a 0.45% prevalence of RSLVNs shows they are not so rare as previously reported. Except for configuration, all nodules had similar intensity, and none showed contrast enhancement. Absence of changes during the follow-up period seemed to indicate that the nodules have no clinical significance. However, their clear differentiation avoids unnecessary surgery.

Keywords: lateral ventricle, magnetic resonance imaging, nodule, ring-shaped, ventricular nodule

Introduction

In 2009, Shimono and associates1 first described the magnetic resonance (MR) imaging features of ring-shaped lateral ventricular nodules (RSLVNs) smaller than one cm in diameter and reported a prevalence of only about 0.023%. However, our observation of several RSLVNs on brain MR imaging led us to examine the prevalence and imaging characteristics of RSLVNs detected by pre- and postcontrast brain MR imaging.

Materials and Methods

In accordance with the policies for exemption of our institutional review board, we retrospectively reviewed cranial images of 1,241 patients who underwent contrast-enhanced brain MR imaging in our institution from January 1, 2008 through March 31, 2011. Most patients had or were suspected of having a brain tumor. We excluded images of 130 patients–images of inadequate quality, such as images with collapsed ventricles, and images of intraventricular disseminated lesions from malignant...
brain tumors that we excluded based on clinical history. We ultimately analyzed images of 1,111 patients (544 male, 567 female; aged 0 to 85 years, mean age 51.4 years).

All patients underwent imaging on either of two 1.5-tesla MR imagers (Achieva Nova Dual, Philips Medical Systems, Best, the Netherlands; Magnetom Avanto, Siemens Medical Systems, Erlangen, Germany).

For Achieva Nova Dual, the standard MR imaging protocol for axial T₁-weighted images (T₁WI) was: repetition time (TR)/echo time (TE), 420/12 ms; field of view (FOV), 20.7 cm; matrix, 272 × 171; and slice thickness, 5 mm with 1.5-mm interslice gap. For axial T₂-weighted images (T₂WI), parameters were: TR/TE, 4179/90 ms; FOV, 20.7 cm; matrix, 320 × 247; and slice thickness, 5 mm with 1.5-mm interslice gap. For axial fluid-attenuated inversion recovery (FLAIR) images, parameters were: TR/TE, 2600 ms; FOV, 20.7 cm; matrix, 288 × 204; and slice thickness, 5 mm with 1.5-mm interslice gap. For axial diffusion-weighted images (DWI), parameters were: TR/TE, 3844/65 ms; FOV, 20.7 cm; matrix, 144 × 87; and slice thickness, 5 mm with 1.5-mm interslice gap. For contrast-enhanced 3-dimensional (3D) T₁WI images, parameters were: TR/TE, 10000/100 ms; inversion time (TI), 2600 ms; FOV, 20.7 cm; matrix, 288 × 204; and slice thickness, 5 mm with 1.5-mm interslice gap. We obtained axial, coronal and sagittal reconstruction images with 5-mm thickness.

For Magnetom Avanto, the standard MR imaging protocols for axial T₁WI was: TR/TE, 550/8.4 ms; FOV, 20.8 cm; matrix, 256 × 232; and slice thickness, 4 mm with 1.5-mm interslice gap. For axial T₂WI, parameters were: TR/TE, 4200/90 ms; FOV, 20.8 cm; matrix, 256 × 232; and slice thickness, 4 mm with 1.5-mm interslice gap. For axial FLAIR, parameters were: TR/TE, 8000/99 ms; TI, 2500 ms; FOV, 20.7 cm; matrix, 320 × 202; and slice thickness, 5 mm with 1.5-mm interslice gap. For axial DWI, parameters were: TR/TE, 4200/81 ms; FOV, 23.0 cm; matrix, 128 × 102; and slice thickness, 5 mm with 1.5-mm interslice gap. For contrast-enhanced 3D T₁WI, parameters were: TR/TE, 12/4.76 ms; FOV, 20.1 cm; matrix, 256 × 224; and slice thickness, 0.9 mm with no interslice gap. We obtained axial, coronal and sagittal reconstruction images with 5-mm thickness.

Two radiologists, with 3 (R. N.) and 35 (A. U.) years’ experience in evaluating MR images retrospectively assessed number, location (right or left, anatomical region), shape, and maximum diameter of RSLVN on all images and resolved any difference by consensus. We evaluated images using the SYNPSE (Fujiﬁlm Medical Company, Tokyo, Japan) picture archiving and communicating system (PACS) and diagnosed RSLVN based on MR findings of a ring-shaped nodule smaller than one cm in diameter on the lateral ventricular wall on axial image.

In addition, we classified signal intensity of the ring on T₁WI, T₂WI, FLAIR, and DWI images as low, iso, or high compared to surrounding white matter and assessed the contrast enhancement characteristics of the nodules. If follow-up MR imaging studies were performed, we assessed changes in the lateral ventricular nodules.

Informed consent was not required for the retrospective clinical study.

Results

Among 1,111 patients, we found 6 nodules (right 2, left 4) in 5 patients (0.45%; 3 men, 2 women; mean age 55 years, range 37 to 62 years).

Table summarizes characteristics of all 5 patients, including MR imaging findings. Three of the 5 patients demonstrated no abnormal MR findings other than the RSLVN, one had Tolosa-Hunt syndrome, and one had meningitis. Four patients had a single lateral ventricular nodule (Figs. 1–4), and one had a nodule in each of the bilateral ventricles (Fig. 5).

Nodules were located on the frontal horn in 4 patients and in the roof of the body in two. The mean maximum diameter of the 6 RSLVN was 6 mm (range 3 to 9 mm). Three were round (mean diameter, 4 mm), two were oval (mean maximum diameter, 7.5 mm), and one was lobular (maximum diameter, 7 mm) (Fig. 4) on axial images. Four of the 5 patients had undergone serial MR imaging with mean follow-up of 15 months (range, 8 to 24 months). None of the five nodules examined serially showed morphological changes over the follow-up interval.

For all 6 nodules, signal intensity of the ring relative to the adjacent brain parenchyma and of the core portion relative to the cerebrospinal fluid (CSF) on T₁WI, T₂WI, and DWI was isointense. On FLAIR images, all 6 nodules were hyperintense and showed no contrast enhancement.

No histopathological examinations of surgical or biopsy specimens were performed.

Discussion

Shimono’s group1 first described RSLVN in 2009 in a review of brain MR images from a radiological database, reporting the prevalence of
Table. Magnetic resonance imaging findings of 5 patients with ring-shaped lateral ventricular nodules

<table>
<thead>
<tr>
<th>Case No</th>
<th>Age/ Sex</th>
<th>Clinical diagnosis</th>
<th>Location</th>
<th>Shape/ Diameter</th>
<th>Signal intensity on T1WI</th>
<th>Signal intensity on T2WI</th>
<th>Signal intensity on FLAIR</th>
<th>Signal intensity on DWI</th>
<th>Contrast enhancement</th>
<th>Outcome/Follow-up period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>62/M</td>
<td>Agnosia</td>
<td>Right frontal horn</td>
<td>Oval/ 6 mm</td>
<td>Isointense</td>
<td>Isointense</td>
<td>Hyperintense</td>
<td>Isointense</td>
<td>None</td>
<td>No change/ 20 months</td>
</tr>
<tr>
<td>2</td>
<td>46/M</td>
<td>Headache</td>
<td>Left frontal horn</td>
<td>Oval/ 9 mm</td>
<td>Isointense</td>
<td>Isointense</td>
<td>Hyperintense</td>
<td>Isointense</td>
<td>None</td>
<td>Not applicable</td>
</tr>
<tr>
<td>3</td>
<td>37/M</td>
<td>Tolosa-Hunt Syndrome</td>
<td>Left frontal horn</td>
<td>Round/ 6 mm</td>
<td>Isointense</td>
<td>Isointense</td>
<td>Hyperintense</td>
<td>Isointense</td>
<td>None</td>
<td>No change/ 8 months</td>
</tr>
<tr>
<td>4</td>
<td>60/F</td>
<td>Numbness</td>
<td>Roof of left body</td>
<td>Lobular/ 7 mm</td>
<td>Isointense</td>
<td>Isointense</td>
<td>Hyperintense</td>
<td>Isointense</td>
<td>None</td>
<td>No change/ 24 months</td>
</tr>
<tr>
<td>5</td>
<td>55/F</td>
<td>Meningitis</td>
<td>Roof of right body</td>
<td>Round/ 3 mm</td>
<td>Isointense</td>
<td>Isointense</td>
<td>Hyperintense</td>
<td>Isointense</td>
<td>None</td>
<td>No change/ 10 months</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Left frontal horn</td>
<td>Round/ 4 mm</td>
<td>Isointense</td>
<td>Isointense</td>
<td>Hyperintense</td>
<td>Isointense</td>
<td>None</td>
<td>No change/ 10 months</td>
</tr>
</tbody>
</table>

Signal intensity: We determined signal intensity of the ring of nodules compared to brain parenchyma.

DWI, diffusion-weighted image; FLAIR, fluid-attenuated inversion recovery; T1WI, T1-weighted image; T2WI, T2-weighted image

Fig. 1. Case 1. A 62-year-old man with agnosia. (a) Axial T1-weighted image (T1WI) shows a ring-shaped lateral ventricular nodule (RSLVN) at the roof of the right frontal horn (arrow) with signal isointense relative to the brain. (b) Postcontrast T1WI shows the nodules with no contrast enhancement (arrow).

RSLVNs smaller than one cm in diameter as 0.023 % (nine of 39,607 patients). However, we found their prevalence to be almost 20 times higher (0.45 %). Several factors may affect this extreme discrepancy between the 2 studies. First, we retrospectively reviewed all images, whereas Shimono’s group reviewed only radiological reports and may therefore have overlooked or ignored many tiny RSLVNs observed daily in the clinic. Second, the 2 studies followed different protocols. In particular, we used 5-mm slice thickness, and Shimono’s study used 6-mm thickness, and thicker slice is inadequate to detect the tiny RSLVNs. Third, by adding contrast-enhanced 3D T1-weighted images in all patients, we evaluated many more images than reported in Shimono’s study. We therefore believe that our observation of 0.45% prevalence is more reliable than the previous report.

All RSLVNs showed isointense signal on T1WI, T2WI, and DWI, hyperintense signal on FLAIR images, and isointense signal of the core portion relative to CSF on T1WI and T2WI. None showed contrast enhancement. We considered the nodules to be cystic lesions based on their signal intensity.
Neither did the lesions show rapid growth. Similar MR imaging features and anatomical location in the roof of body or frontal horn of the lateral ventricles resembled Shimono’s findings. The only difference between our results and those of Shimono was the signal intensity on FLAIR images; they reported two of 8 rings of nodules to be isointense relative to the brain. These nodules or thin-walled nodules may tend to show isointensity.

Shimono’s group also noted the round shape of RSLVN on axial images, whereas we found round, oval, and lobular configurations. Although the reasons underlying the different configurations remains unclear, the lobular configuration also showed ring-shaped nodule on axial image. We consider this type of nodule to be an RSLVN variant and possibly caused by rupture of a round nodule or osmotic pressure gradient between cerebrospinal fluid and fluid in the RSLVN. Unfortunately, there are no histopathological findings of RSLVNs for any of the patients scanned in either study. However, based on findings of both studies, we observed that RSLVN characteristically showed no morphological changes of nodules over follow-up of 8 to 60 months and were seen in middle-aged men and women and not children. Thus, we believe RSLVNs are acquired benign lesions. Their variations include: neuroglial, glioependymal, or ependymal cyst; inflammatory or reactive nodular formation of ependymal cyst; and variants of subependymoma or other lateral ventricular tumors. We propose that RSLVN is a prestage or variant of subependymoma because of the similar radiological and clinical findings of these two. Subependymomas are small lesions in the lateral ventricle, rare ependymal neoplasms usually smaller than 2 cm in diameter and round, and should be considered when a well defined nonenhancing tumor is found, generally incidentally, in the lateral ventricle of middle-aged and elderly adults.

Differential diagnoses of other lateral ventricular mass lesions include astrocytoma, meningioma, choroid plexus tumor, central neurocytoma, subependymal heterotopia, subependymal nodule, ependymoma, lymphoma, and metastasis. Because subependymomas, subependymal heterotopies, and subependymal nodules are small lesions
in the lateral ventricle, it is important to distinguish them from RSLVNs. Subependymal heterotopia and subependymal nodule can be diagnosed based on clinical history and radiological findings. Subependymal heterotopia has been observed either as a solitary nodules (nodular subependymal heterotopia) projecting into the ventricles or as diffuse broad bands (diffuse subependymal heterotopia) lining the ventricles; nodules are either round or ovoid, and the lesions appear isointense to normal gray matter on all sequences. Subependymal nodules are found in patients with tuberous sclerosis and exhibit a one- to 12-mm diameter, variable signal intensity on MR imaging, and often calcification; most demonstrate some enhancement.

Reported only once in radiological journals, RSLVNs may be unfamiliar among neurosurgeons and radiologists other than neuroradiologists. If a neurosurgeon finds these nodules during ventriculoscopy, they can perform biopsy, but such biopsy has not been reported because of the low prevalence of RSLVNs and their incidental discovery.

Our study is limited because it is a retrospective assessment of MR images, the RSLVNs were not identified by histopathological examination of surgical or biopsy specimens, and our follow-up period was too short.

In conclusion, our MR imaging study revealed a 0.45% prevalence of RSLVNs, which is not so rare as previously reported. Except for their configurations, all nodules demonstrated similar intensity and no contrast enhancement and were thought to be cystic lesions according to their MR imaging characteristics. None of the nodules examined seri-
ally showed morphological changes over the follow-up interval. Nevertheless, knowledge of the MR imaging findings of RSLVNs is clinically important because they are benign and require follow-up observation rather than immediate surgical treatment.

Conflict of interest: We declare we have no conflict of interest.

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References