Large Virchow-Robin Spaces: 
MR-Clinical Correlation

High-field MR scans frequently show Virchow-Robin spaces, which conform to the path of the penetrating arteries as they enter either the basal ganglia or the cortical gray matter over the high convexities. A retrospective review of 816 MR scans was undertaken to determine the clinical significance and associations (if any) of this finding. The Virchow-Robin spaces were graded, as were the nonspecific white-matter lesions. The presence of atrophy, infarction, hydrocephalus, and miscellaneous disease was noted. Large Virchow-Robin spaces were identified in 314 cases. A study sample was created consisting of a positive group containing all the larger grade 2 and 3 Virchow-Robin spaces (67 patients) and a negative or control group of 109 randomly selected patients from the original 502 who did not have large Virchow-Robin spaces. The charts of this study sample were reviewed and the following patient variables were noted: age, gender, incidental white-matter lesions, infarction, dementia, hypertension, and atrophy. For each variable, the proportion of patients who were positive for that variable was calculated for each of the two groups and compared across groups by using a Fisher exact test. Multiple logistic regression analysis was used to determine whether any of these variables were jointly associated with being "positive" or "negative" for large Virchow-Robin spaces. Some variables were strongly associated with being positive for large Virchow-Robin spaces: age, hypertension, dementia, and incidental white-matter lesions. Logistic regression analysis revealed that when all of these variables are considered jointly, only age remains significant.

In conclusion, large Virchow-Robin spaces are another phenomenon of the aging brain. Factors such as hypertension, dementia, and incidental white-matter lesions were significantly associated with large Virchow-Robin spaces, but were believed to accompany the aging process rather than represent independent variables.

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High-field MR scans routinely demonstrate small foci of CSF signal on all pulse sequences about the base of the brain. These lesions conform to the path of the lenticulostriate arteries as they enter the basal ganglia through the anterior perforated substance and represent large Virchow-Robin spaces, which accompany the vessel as it penetrates the brain from the subarachnoid space. Occasionally, these perforations have been seen in the high-convexity gray matter extending into the centrum semiovale, where they follow the course of the penetrating cortical arteries. A retrospective review of 816 MR scans was undertaken to determine the clinical significance and associations, if any, of this anatomy.

Materials and Methods

All outpatients who had an MR scan of the brain between October 1986 and August 1987 on a 1.5-T General Electric Signa unit were retrospectively reviewed for the presence or absence of large Virchow-Robin spaces. The routine examination consisted of three spin-echo sequences, all done with a 256 × 256 matrix and one excitation: (1) axial images, 600-800/20 (TR/TE), with a 5-mm section thickness and 5-mm gap; (2) axial multiecho images,
Large Virchow-Robin spaces were identified in 314 patients. The age distribution of these patients is given in Figure 1, where it is compared with the age distribution of the 502 cases negative for Virchow-Robin spaces. Note that it is in the two older groups that the percentage of positives exceeds that of the negatives. More specifically, it is in the 61–80 age group that the percentage of patients positive for Virchow-Robin spaces is significantly greater than the percentage of those who are negative.

Table 1 illustrates the prevalence of the various grades of Virchow-Robin spaces found in each age group. In general, Virchow-Robin spaces increased with increasing age, but larger Virchow-Robin spaces (grades 2 and 3) had a much stronger correlation with age while the milder grade 1 spaces were more ubiquitous.

Lenticulostriate Virchow-Robin spaces were common and mildly age-related, while high-convexity spaces were rarer and had a much stronger correlation with age, as illustrated in Figures 2–4. Two hundred eighty-five patients (35%) had lenticulostriate spaces, 102 (13%) had high-convexity spaces, and 74 (9%) had both.

In the study sample in which only the age distribution of the larger Virchow-Robin spaces (grades 2 and 3) was analyzed and compared with the control group, the correlation with age was further strengthened (Fig. 5).

Figure 6 shows that patients who were positive for Virchow-Robin spaces were more likely to have nonspecific white-

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MR OF LARGE VIRCHOW-ROBIN SPACES

Fig. 2.—Age-specific prevalence of lenticulostriate Virchow-Robin spaces seen on MR.

Fig. 3.—Age-specific prevalence of high-convexity Virchow-Robin spaces seen on MR.

Fig. 4.—Age-specific prevalence of type of Virchow-Robin space among 67 large Virchow-Robin spaces (grades 2 and 3). HC = high convexity; LS = lenticulostriate.

Fig. 5.—Age distribution of patients with large (grades 2 and 3) Virchow-Robin spaces vs controls.

Fig. 6.—Prevalence and severity of white-matter lesions in patients with large (grades 2 and 3) Virchow-Robin spaces vs controls.

Fig. 7.—Prevalence of dementia in patients with large (grades 2 and 3) Virchow-Robin spaces vs controls.
Some variables were significantly associated with being positive for large Virchow-Robin spaces: age \((p = .0001)\), hypertension \((p = .009)\), dementia \((p = .011)\), and incidental white-matter lesions \((p = .0001)\). Gender (more males than females) also was mildly significant \((p = .04)\). Although stroke and atrophy occurred with higher frequencies in the positive group, these results were not statistically significant (Figs. 6–11). All the cortical infarctions had a clinical history of ictus while lacunar infarcts had a history of ictus in only half the cases.

Owing to small numbers, stroke and atrophy were excluded from the logistic regression analysis. Logistic regression was carried out on age, gender, hypertension, dementia, and white matter. The analysis revealed that, when all these clinical variables were considered jointly, only age remained significant \((p = .0002)\).
The second analysis showed no significant association of the high convexity/lenticulostriate grouping with any of the variables, except for a weak association with hypertension ($p = .05$); patients with both high convexity and lenticulostriate Virchow-Robin spaces were more likely to have a history of hypertension.

Discussion

In the past, the perivascular space has been the exclusive domain of the anatomists and pathologists, as no imaging technique had the resolution required to visualize such anatomic detail. While Pestalozzi in 1849 (cited in [1]) was probably the first to describe a perivascular space, what has become known as a Virchow-Robin space was described in 1851 by Virchow [2], a German pathologist, as a subadventitial space that was contiguous around the capillaries. In 1859, Robin [3], a French anatomist, described a space he regarded as intraadventitial and closed. Today, the eponym refers to the extension of the subarachnoid space, which accompanies the vessel penetrating the cerebral cortex to the level of the capillaries (Fig. 12) [1, 4]. While late-generation CT scanners have enabled the visualization of pathologic processes dilating the Virchow-Robin spaces [5], it is only with the advent of high-field MR imagers and their greater resolution that presumably “empty” CSF-filled Virchow-Robin spaces have been routinely visualized [6, 7].

MR scans obtained at 1.5 T routinely demonstrate small foci of CSF signal on all pulse sequences on either side of the anterior commissure at the level of the inferior one third of the basal ganglia; that is, in the anterior perforated substance (Figs. 13 and 14). These Virchow-Robin spaces follow the path of the lenticulostriate arteries as they enter the basal ganglia through the anterior perforated substance (Figs. 15 and 16). Infrequently, Virchow-Robin spaces are seen in the high-convexity gray matter extending into the centrum semi-
ovale (Figs. 17 and 18), where they follow the course of the
penetrating cortical arterioles (Fig. 19). The artery contained
within the large Virchow-Robin space is not identified on MR
because the associated perivascular space is so much larger
and the size of the vessel itself (usually 0.4 mm and under) is
beyond the limits of the scanner's resolution (0.93 mm with a
5-mm slice and 24-in. [61-cm] field of view) (Figs. 16B and
19).

Occasionally, it is difficult to differentiate a lacunar infarct
from a large perivascular space, but in our experience and
others [6–8] infarcts occur in the upper two thirds of the
basal ganglia and are usually not of CSF intensity on all pulse
sequences. Infarcts tend to be hyperintense or have hyper-
tense edges on long TR/short TE images and they tend to
be larger, usually measuring 5 mm in diameter or more.
Perivascular spaces are far more symmetric and bilateral
(85% of our cases) than lacunae as well. A new classification
of cerebral lacunae was proposed in the pathologic literature
by Poirier and Derouesne [9]. Type I lacunae refer to old,
small infarcts; type II lacunae refer to old, small hemorrhages;
and type III lacunae refer to dilated perivascular spaces. The
authors specifically described a type IIIC lacuna correspond-
ing to perivascular dilatation at the entrance of a perforating
artery into the lenticular nucleus. This clearly corresponds to
our dilated Virchow-Robin spaces about the lenticulostriate
arteries.

Our results indicate that small (grade 1) Virchow-Robin
spaces are found in all age groups and probably represent
normal anatomy. Grade 1 Virchow-Robin spaces were seen
in 23% of cases under age 20, in 33% of cases aged 21–40,
in 28% of cases aged 41–60, in 33% of cases aged 61–80,
and in 18% of cases aged 80 and over (Table 1). High-
convexity spaces are less common and much more age-
related than lenticulostriate spaces, although both are found
with increasing size and frequency with advancing age (Figs.
1–5).

Age, hypertension, dementia, and incidental white-matter
lesions were found to be significantly associated with large
Virchow-Robin spaces (grades 2 and 3). Infarction and atro-
phy occurred more frequently with large spaces as well, but
the numbers were not statistically significant (Figs. 6–11).
Atrophy was noted only if it was not appropriate for the
patient's age, so it must be remembered that age in this
cohort is also an index of atrophy. The multiple logistic
regression analysis revealed that when all the above variables
were considered jointly, only age remained significant. The
interpretation is that age alone accounts for the differences
between groups and that the other variables do not inde-
pendently distinguish between groups. This result is not sur-
prising, since these clinical variables are so highly correlated
with age. Because the Virchow-Robin space is an extension
of the subarachnoid space, it should be expected that it would
enlarge with age, as the subarachnoid space does elsewhere
in the brain. In conclusion, large Virchow-Robin spaces are
another phenomenon of the aging brain.

Fig. 15.—Gross specimen sectioned in coronal plane. Lenticulo-
striate arteries (straight black arrows) are seen passing through anterior perfo-
rated substance (white arrows) at level of anterior commissure (curved
arrows). Perivascular spaces are not enlarged.

Fig. 16.—A, Severe dilated Virchow-Robin spaces (straight arrows) about anterior commis-
sure (curved arrow) in gross specimen sectioned in coronal plane.
B, Accompanying histologic section with pial-
lined (arrowhead) perivascular space. Vessel
(arrow) measures 0.25 mm in diameter and
space measures 1.05 mm (grade 1). MR was
performed on this specimen. (H and E, x4)
Fig. 17.—61-year-old man with basal ganglia hemorrhage and hypertension. A-C, 800/20 (A), 2000/40 (B), and 2000/80 (C) images show high-convexity Virchow-Robin spaces perforating cortex (arrows). D-F, 800/20 (D), 2000/40 (E), and 2000/80 (F) images show high-convexity Virchow-Robin spaces extending into periventricular white matter (arrows).

Fig. 18.—83-year-old man with vertebral basilar ischemia. A-C, Sagittal images (800/20) show high-convexity Virchow-Robin spaces traversing corona radiata (arrows) from lateral to medial.
Fig. 19.—Histologic section of high-convexity Virchow-Robin space (straight arrow) containing longitudinally sectioned arteriole (arrowheads) in centrum semiovale. Note corticomedullary junction (curved arrow). MR was not performed in this case. (H and E, x4)

ACKNOWLEDGMENTS

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REFERENCES