Virchow-Robin spaces (VRS) are invaginations of the subarachnoid space, containing cerebrospinal fluid (CSF), that accompany small arteries and arterioles as they penetrate the surface of the brain [1, 2]. They conform to the path of the penetrating arteries as they enter the basal ganglia or cortical grey matter over the convexities but may also extend into the centrum semiovale [2, 3]. Dilated VRS or microvascular changes within the region of the small penetrating arteries and arterioles, presenting as small or punctate lesions, are sensitively detected by MRI [3].

In adults, VRS within the cerebral hemispheres are commonly seen in the absence of functional disorders and presumably represent an anatomic variant. Dilated VRS within the white matter have been described in children with mucopolysaccharidosis [4]. A recent study found a statistically significant increase in dilated VRS within the cerebral white matter in children suffering from chronic primary headache [1], but did not relate this to the type of headache. We reviewed the MRI of children with migraine or tension-type headache (TTH), focusing on possible morphological differences between these two major types of headache. We also wished to investigate cross-sectionally whether possible changes in childhood migraine also are detectable in adult migraineurs, and whether children with migraine differ from nonmigrainous age-matched controls.

Abstract     Virchow-Robin spaces (VRS) are pia-lined extensions of the subarachnoid space which surround penetrating arteries as they enter the brain on its surface. Using high-resolution MRI, which shows small penetrating arteries, we studied a possible association of accentuated VRS in children with tension-type headache (TTH) or migraine. We studied 58 children aged 3–14 years (mean 10.8 years) with a clinical diagnosis of migraine (31) or TTH (27), who underwent cerebral MRI, and 30 headache-free patients of the same age (mean 10.2 years) and 30 adult migraineurs with postpubertal onset of symptoms, who served as controls. The images were reviewed for structural abnormalities in the regions of the small penetrating arteries. Accentuated VRS were found in 61 % of the children with migrainous headaches and in 22 % of children of those with TTH. Prominent VRS were seen in 27 % of the control children and in only 13 % of the adults. Small infarcts and gliosis were rare in children with or without headache, but were seen in 30 % of the adult migraineurs. Our findings show that accentuated VRS are significantly more common in children with migraine than in those with TTH or headache-free controls. Detection of accentuated VRS may therefore enhance differential diagnosis of primary headaches in children, contributing to an improvement in management.

Key words     Virchow-Robin spaces · Magnetic resonance imaging · Childhood migraine
During a 12-month period, 58 children referred to a specialised outpatient clinic for recurrent headache underwent cranial MRI. There were 28 boys and 30 girls, aged 3–14 years, average age 10.8 years. Our controls included 30 randomly selected headache-free children of the same age range (mean 10.2 years), referred for MRI because of psychiatric disorders (none with neurological signs) and 30 patients aged 22–55 years with adult-onset migraine. The diagnosis was established according to the criteria of the International Headache Society (IHS) [5, 6], based on history and neurological findings. At the one-digit level of the IHS classification, 31 children were classified as having migraine and 27 TTH. Patients with clinically suspected symptomatic headache or with coexisting migraine and TTH were not included.

MRI was performed on 0.5-, 1.0- and 1.5-T superconducting systems. A circularly polarised head coil was used, to increase the signal-to-noise ratio. Images (slice thickness 3–5 mm, 50 % interslice gap) were acquired in the axial plane and sometimes in the sagittal or coronal planes, using T1- (TR/TE 600–700/15–20 ms), proton-density (PD), T2- (2000/15/90), and T2-weighted fast spin-echo (TR/TE 3000–4000/100–120) sequences and fluid attenuation inversion recovery (FLAIR) sequences (TR/TE/TI 6000–7000/100–130/2000 ms), a field of view 230 mm, matrix 256 × 256.

All images were assessed by one neuroradiologist, unaware of the clinical diagnosis. They were analysed for any remarkable structural abnormalities in the region of the small penetrating arteries and arterioles, i.e. VRS, microinfarcts, and gliotic spots (Table 1). VRS were defined, according to Rollins et al. [1], as spaces in the white matter of the cerebrum with a signal intensity similar to that of CSF on all pulse sequences (Fig.1). The VRS were regarded as pathological (“accentuated”) when they were visible in the white matter of one hemisphere, in one or both hemispheres in “clusters” (Fig.2), or uni- or bilaterally in the deep white matter. On proton density (PD) and FLAIR images, VRS give CSF-intensity signal only when sufficiently large; otherwise, they appear isointense with surrounding brain (Table 2). VRS around the anterior commissure and in the brain stem were considered an anatomical variants and not abnormal (Fig.3) [1].

For statistical analysis we applied Chi-square tests. A P value < 0.05 was considered statistically significant.

### Results

Accentuated VRS were found in 61 % of children with migraine (Fig.2), but in only 22 % of those with TTH. VRS were found in 27 % and 13 %, respectively of the children without headache and the adult migraineurs. The prevalence of VRS in childhood migraine was significantly greater than in those with TTH, headache-free children or adult migraineurs (P < 0.05). The prevalence of VRS in children with TTH did not differ significantly from that in headache-free controls.

Microinfarcts and gliotic spots were seen in 10 % of the children with migraine, 11 % of those with TTH and only 3 % of those without headache, but in 30 % of the adult migraineurs. The prevalence of microinfarcts and gliotic spots was similar in children with migraine, TTH, and headache-free controls, but was significantly greater in adult migraineurs (P < 0.05) (Table 3).

### Discussion

In this study, the accentuated VRS were used as a morphological guideline to enhance differentiation between migraine and TTH in children. Our findings were that accentuated VRS are significantly more common in those with migraine than in those suffering from TTH or the control groups.

Dilated VRS are significantly associated with age, hypertension and dementia [3].