Neuroradiology (1996) 38: 547–550

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The "target sign": is it a specific sign of CNS tuberculoma?

Received: 23 November 1994
Accepted: 30 August 1995

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Abstract In brain lesions, the target sign has been defined as a central nidus of calcification or central enhancement surrounded by a ring of enhancement. It has been considered a pathognomonic finding of central nervous system (CNS) tuberculoma. The purpose of this report is to demonstrate that the target sign related to central enhancement is a nonspecific finding and may lead to erroneous diagnosis of CNS tuberculoma.

Key words Target sign · Tuberculoma · Computed tomography · Central nervous system · Magnetic resonance imaging

Introduction

Welchman [1] first described the target sign in 1979 in brain lesions on CT, as a central nidus of calcification or central enhancement surrounded by a ring of enhancement, stating that it might be pathognomonic of central nervous system (CNS) tuberculoma. Van Dyk [2] supported this opinion, reporting 12 cases of tuberculoma showing the target sign.

This finding is important because of the high incidence of neurotuberculosis in underdeveloped countries and its increasing frequency in developed countries due to its association with AIDS.

Clinically, CNS tuberculosis presents as meningitis, although isolated parenchymal forms indistinguishable from other brain processes can be found, accounting for 36–71 % of all forms [3, 4]. In developing countries, intracranial tuberculoma may represent 10–30 % of all intracranial masses [5, 6].

This report shows the target sign on CT caused by lesions other than tuberculoma, such as primary brain lymphoma, toxoplasmosis and bacterial abscess. We also describe the appearance of the target sign on MRI.

Case reports

Case 1

A 25-year-old man suffering from AIDS with a long history of brain toxoplasmosis was investigated for seizures. Unenhanced CT showed a low-density lesion involving the right parietal lobe. Contrast-enhanced CT revealed a ring-enhancing lesion with central enhancing dots giving a target appearance (Fig. 1). The diagnosis of toxoplasmosis was made on the basis of the clinical and radiographic improvement after treatment.

Case 2

A 27-year-old man suffering from AIDS was admitted with a left-sided hemiparesis. CT showed a large, low density lesion surrounded by an irregular, thick, dense wall. A central dot of high attenuation was present. The lesion was located in the right temporoparietal region and was surrounded by a large amount of vasogenic oedema producing mass effect on the right lateral ventricle. Contrast-enhanced CT showed marked enhancement of both lesion wall and central dense area (Fig. 2). A diagnosis of primary brain lymphoma was made by biopsy.

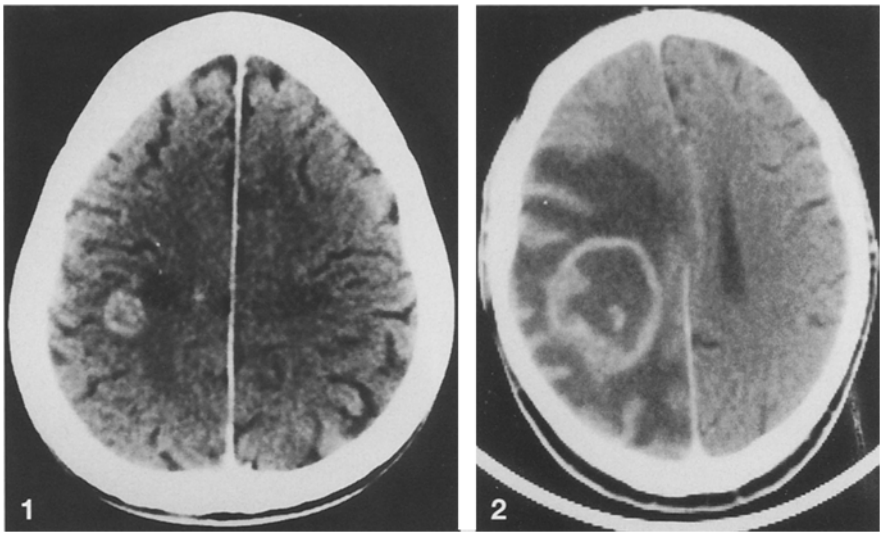

Fig. 1 Case 1: 25-year-old man with AIDS. Toxoplasmosis. Contrast-enhanced CT shows right parietal target sign

Fig. 2 Case 2: 27-year-old man with AIDS. Primary cerebral lymphoma. Contrast-enhanced CT shows a right parietal target sign. Note irregular and thickened dense ring with surrounding oedema and mass effect

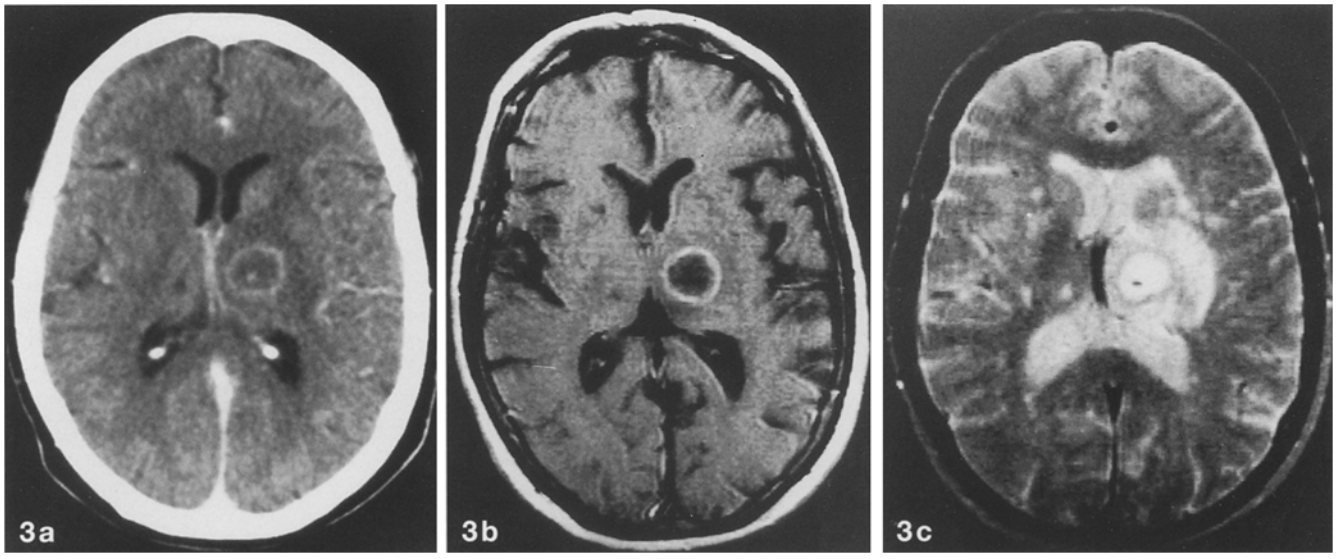

Fig. 3 a–c Case 3: 74-year-old woman. Pyogenic abscess. **a** Contrast-enhanced CT shows left deep temporal target sign. A lacunar lesion is also seen in the thalamus on the right. **b** Post-gadolinium-DTPA MRI (600/27; 0.5 T) shows ring enhancement but central dot is not observed. **c** T2-weighted (2000/90; 0.5 T) MRI shows isointense ring with low-signal central dot. Surrounding oedema and multiple lacunar lesions are also seen

Case 3

A 74-year-old woman was admitted with a right-sided hemiparesis and aphasia. CT showed a lesion in the thalamic and internal capsular regions on the left, consisting of a low density centre surrounded by a dense ring, and associated with vasogenic edema. Following administration of contrast medium, ring and punctate central enhancement were seen (Fig. 3 a). MRI was performed on a 0.5 T unit. T1-weighted spin-echo images (TR/TE 600/72) showed a heterogeneous central low-signal area surrounded by an isointense (relative to gray matter) ring. After intravenous gadolinium-DTPA administration a regular thin ring of enhancement was seen (Fig. 3 b). T2-weighted images (TR/TE 2000/90) revealed a high-signal lesion surrounded by a complete, thin ring and containing a central low-signal dot giving a target appearance (Fig. 3 c). Because of its MRI characteristics the central dot was thought to represent haemosiderin. A diagnosis of brain abscess was made by means of ultrasound-guided aspiration, microbiological examination identifying Peptostreptococcus.

Discussion

Many infectious and neoplastic mass lesions of the CNS may have a similar appearance on CT and MRI. The size of the lesion, thickness or sharpness of a ring (if present), mass effect and oedema are nonspecific findings. The target sign has been considered specific for tuberculoma. Welchman [1] presented four tuberculomas with the target sign: three with central calcification and one with a central focus of enhancement. Van Dyk [2]

presented 12 tuberculomas, nine with central calcification and the remaining three with central enhancement. This central area of enhancement could be irregular or like a central dot. Central calcification varied in appearance from regular and small to irregular and large. In Van Dyk's series, the target sign was mainly observed in children. In developed countries tuberculomas occur mainly in adults, which could account for the low incidence in Europe or the United States [7].

Up to 39 % of patients with AIDS have neurological symptoms [8]. As these patients often have multiple, simultaneous, intracranial diseases, the differential diagnosis becomes more complicated. Several studies have attempted to establish diagnostic criteria in order to differentiate each process, but such differentiation based on imaging findings has not been possible [8–10]. Toxoplasmosis and primary CNS lymphoma are the most frequent mass lesions involving the brain in these patients, but tuberculosis (TB) should also be considered since it accounts for 2–18 % of CNS mass lesions. This wide range depends on the prevalence of TB in the general population and the rate of intravenous drug abusers in whom TB is more frequent than in homosexuals [11].

We have presented three patients with the target sign, but without CNS tuberculosis. Two of the patients suffered from AIDS and had toxoplasmosis and primary brain lymphoma. In these patients, MRI would have been useful in the differential diagnosis since tuberculomas generally demonstrate a characteristic low signal on T2-weighted images [12] secondary to the presence of fibrosis, gliosis and a high lipid content [13] whereas other infectious processes and tumours give high signal.

The last patient had a pyogenic abscess and MRI allowed us to exclude tuberculoma with a high degree of confidence. The signal characteristics of the capsule and particularly its moderately high signal on T1-weighted images have been attributed to the presence of free radicals produced by macrophage activity [14]. The low-signal centre reflects necrosis and the proteinaceous nature of the abscess fluid. The core of the lesion representing the centre of the target sign appears as a markedly low signal on T2-weighted images and most likely contains calcification or haemosiderin. In our case, we consider the low signal secondary to the presence of haemosiderin since no calcification was seen on CT. Solid caseating granulomas may also appear of low signal on T2-weighted images; however, we did not think that our case could be confused with a tuberculoma on the basis of MRI findings since tuberculomas have not been described with a central low-signal dot. On the contrary, when a mature tuberculoma evolves to a tuberculous abscess a central high signal appears which gradually expands to the periphery [7].

To our knowledge, the target sign on CT in toxoplasmosis, bacterial abscess and primary cerebral lymphoma has not been previously described [15–17]. The presence of concentric bands of varying signal intensity and thickness has frequently been found in pyogenic abscesses [14]. A focus of enhancement adhering to the wall of the lesion (asymmetrical target appearance) has been shown in toxoplasmosis [18]. We consider this appearance a pseudotarget sign, since the core of a target should have not contact with the wall of the lesion.

According to Welchman [1] and Van Dyk [2], the core of the target sign is constituted by calcium or by contrast enhancement. These authors considered both to be a pathognomonic feature. However, we believe one should distinguish the target sign related to calcium from that related to contrast enhancement. The former is a specific feature of CNS tuberculoma, as demonstrated by Welchman and Van Dyk, but the latter is a nonspecific sign and should not be interpreted as evidence of tuberculoma.

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