Balo’s concentric sclerosis in a patient with spontaneous remission based on magnetic resonance imaging: A case report and review of literature

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Abstract
Balo’s concentric sclerosis (BCS) is a rare monophasic demyelinating disease known as multiple sclerosis subtype and seen as a round lesion with variable hyper and hypodetoxification layers. Characteristic appearance can be seen as “bulb eye” or “onion bulb”. The initial terminology for this neurological disorder was leukoencephalitis periaxialis concentrica; this is defined as a disease in which the white matter of the brain is destroyed in concentric layers in such a way as to leave the axial cylinders intact. This report presents a case of BCS with spontaneous healing of the patient and a mass lesion with concentric rings adjacent to the left lateral ventricle and the posterior portion of the corpus callosum with peripheral vasogenic edema. The neurological lesion of the patient was similar to the magnetic resonance imaging and clinical findings of the BCS.
This case report demonstrates that Balo’s concentric sclerosis (BCS) a patient with a mass lesion containing concentric rings, BCS diagnosis was reported by magnetic resonance imaging. As supported in previously reported clinical trials, BCS is not always a fatal disease and supports the definition that it may be a self-limiting disease.

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INTRODUCTION

Balo’s concentric sclerosis (BCS) is characterized radiologically and pathologically by demyelinating lesions with a concentric ring appearance formed by areas of demyelination alternating with relatively preserved myelin\[1\]. The lesions of BCS often occur in isolation or in association with clinically and radiologically more typical multiple sclerosis (MS). Historically, BCS was thought to be uniformly fatal and diagnosis was post-mortem, but in the magnetic resonance imaging (MRI) era, BCS can be detected intra vitam and, in many cases, has a favorable prognosis\[2\].

BCS was first described by Marburg in 1906, and in 1928, the Hungarian neuropathologist, Joseph Balo\[3\] published a report of a student with right hemiparesis followed by optic neuritis, who upon autopsy had demyelinated lesions described as encephalitis periaxialis concentrica. Traditionally, BCS has been grouped under one of the atypical forms of MS, with Marburg’s disease, tumefactive demyelination, Schilder’s disease, and acute haemorrhagic leukoencephalitis, although the contemporary status and usefulness of these categorizations are questionable apart from tumefactive demyelinations contentious. Tumefactive demyelinating lesions are more than 2 cm in size when viewed with MRI and may have an associated mass effect (45%) and/or edema (77%) with larger lesions generally having both more mass effect and edema\[4\]. Most tumefactive demyelinating lesions are focal and supratentorial, with a predilection for the frontal and parietal lobes, but they can present in other areas of the cerebral hemispheres as well as in the deep gray matter, brainstem, cerebellum, and spinal cord\[4,5\].

BCS is clinically indicated in clinical trials that may occur in a manner similar to MS. It is known that it can affect young people and children with mild dementia. However, it may be associated with altered behavior and focal central nervous system (CNS) deficits. Clinical trials have reported that BCS exhibits characteristic radiographic findings that aid in ante-mortem diagnosis\[7\]. BCS is clinically first reported to be a rapidly progressive and lethal condition\[8\], and subsequently reported clinical trials have demonstrated that anti-inflammatory corticosteroids are efficacious against BCS-associated neurological deficits. Because of this reason, it is known that MRI imaging allows early diagnosis and treatment by significantly affecting the course of the disease.

This acute idiopathic inflammatory demyelinating disease has a unique pathological and radiographic signature of concentric demyelination. The pattern can be quite striking upon MRI, with alternating concentric rings of T2 isointensity and hyperintensity related to advancing waves of demyelination. These may show gadolinium enhancement\[9\]. Lesions may be small or occupy large sections of a cerebral hemisphere and tend to spare the cortical U-fibers. Pathologically, there are rings of demyelination corresponding to areas of T2 hyperintensity with MRI alternating with rings of normal myelination or partial remyelination corresponding to areas of T2 isointensity. This renders the lesions with an onion bulb appearance\[10\]. Lesions can also be found in the basal ganglia, pons, cerebellum, and, very infrequently, the spinal cord and optic nerves\[2\]. Patients with this diagnosis were thought to have a fulminant course that was invariably fatal within a year. However, with the advent of MRI, certain cases detected via MRI have had favorable outcomes\[2,11\]. The concentric ring appearance is also not specific, with these types of lesions having also been described in the brainstem in a patient with neuromyelitis optica\[12\] and another with MS\[13\] as well as in patients with progressive multifocal leukoencephalopathy\[14\], cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy\[15\] and concomitant active hepatitis C and human herpes virus 6\[16\].

In this study, we reported a mass lesion with concentric rings adjacent to the left lateral ventricle and the posterior part of the corpus callosum with a peripheral vasogenic lesion in a patient with spontaneous remission with MRI imaging.

CASE REPORT

A 19-year-old woman complaining of night-raging nausea, blurred vision, and severe headache for seven days was seen in our clinic. Focal CNS deficiency was not detected in our patient. On cranial MRI, a mass with concentric circles and peripheral vasogenic edema located right lateral to the left lateral ventricle was seen in the posterior part of the corpus callosum (Figure 1). A significant increase was detected in the peripheries and central region of the lesion after contrast material injection (Figure 2). Diffusion-weighted imaging showed circular rings of...

Key words: Balo’s concentric sclerosis; Multiple sclerosis; Demyelinating; Magnetic resonance imaging; Diffusion-weighted imaging

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been pointed out in scientific publications that BCS is more common in East Asian descent\cite{17,20}. According to these studies, genetic and environmental factors should be considered with BCS. Many signs of Balo’s disease are similar to MS symptoms. Headaches, seizures, muscle pain and spasms, muscle weakness, paralysis over time, difficulty speaking, different thinking or understanding, changes in behavior can be seen as clinical manifestations of BCS. And also, BCS symptoms show a similar clinical course, mostly with intracerebral mass lesions\cite{11,17,18}.

Preservation of cortical gray matter, cerebral white matter oligodendrocyte loss and demyelination are known pathological findings of BCS\cite{20,24}. In the pathology of BCS tissue lesions, the number of oligodendrocytes in the demyelinated areas of the substantia alba layer was reduced, and the lesions were defined as a variation of the immunopathological pattern III of MS\cite{1,22}.

The demyelinated ring appearance of BCS has been reported to include foamy macrophages, activated microglia, reactivated astrocytes and axonal loss areas, as is typically found in MS. It has been reported that hypoxia and demyelination of the edge of BCS lesions are related to the production of chemical mediators and cytokines by macrophages or microglia cells. This provides some protection against demyelination at the BCS lesion side, and as the lesion expands, the demyelination area appears to be a relatively preserved myelinated tissue\cite{1}.

Hypoxia-inducible factor 1α and heat-shock protein 70 are proteins that protect the myelin structure between the rings demyelinated in BCS lesions\cite{25}. BCS lesions are larger than MS lesions in appearance. Different ring appearances are seen with a shape called onion bulb. The formation of this shape is related to relative myelin preservation and the loss of axon structure\cite{1,26}. The myelin structure in BCS patients is rarely preserved. However, it is stated that this is actually a partial demyelination area\cite{1,27}. When the pathological results of BCS lesions are examined, lymphocytic infiltrates around the vessel and demyelination area at different stages are reported\cite{28}. Histological studies on MS lesions indicated that the areas of demyelination may closely resemble the appearance of BCS patients\cite{22,29}. Because of this close anatomical resemblance, some BCS cases have been described as MS cases. Some of the BCS lesions have been found to have lost myelin-associated glycoprotein\cite{1,22}.

In MRI studies, BCS lesions may typically be multiple, isolated, and mixed, such as in MS lesions\cite{31}. Concentric rings can be seen the most common alternative augment rings in the outer rings\cite{32}. In T1-weighted MR scans of BCS lesions, the lesions are generally seen as light or dark (isointense or hypointense) concentric rings. However, in the T2W MRI sequences, it was stated that the density of the lamellae appearance around the lesion increased. Apart from these, it has been reported that the images of BCS lesions may have different geometric shapes\cite{33,34}. The image intensity of MR sections on the outer margin of the BCS lesions was found to be higher\cite{27,25}. It has been stated that in the MR sections of

**DISCUSSION**

It was stated that the case reports presented about the BCS were seen more in women\cite{5,17,26}. However, it has been pointed out in scientific publications that BCS is more common in East Asian descent\cite{17,20}. According to these studies, genetic and environmental factors should be considered with BCS. Many signs of Balo’s disease are similar to MS symptoms. Headaches, seizures, muscle pain and spasms, muscle weakness, paralysis over time, difficulty speaking, different thinking or understanding, changes in behavior can be seen as clinical manifestations of BCS. And also, BCS symptoms show a similar clinical course, mostly with intracerebral mass lesions\cite{11,17,18}.

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the BCS lesions, the flow of the contrast material may be in the peripheral direction. However, it was determined that the density of lesion layers increased in T2-weighted sections\(^7\). BCS lesions are frequently seen in the white matter layer (substantia alba) of the cerebrum. And, subcortical U-fibres are usually initially spared. However, BCS lesions have been reported in the rhombencephalon and the basal ganglia\(^{13,26-38}\). In our case, T2 images revealed an adjacent hyperintense perioedematous concentric lesion at the left centrum semiovale and periventricular white matter spreading to the corpus callosum (Figure 1). Magnetic resonance spectroscopy of the patient indicated a decrease in the choline/N-acetyl aspartate ratio along with mild lipid and lactate peaks (Figure 4). Clinical studies on long-term follow-up of BCS lesions have shown that these lesions lost their ring appearance and turned into demyelinating areas. It has even been reported that the lesions may have a linear shape\(^7\). Other studies have shown that the classic concentric view of the BCS lesion can retain its structure for a long time.

Figure 3 Apparent diffusion co-efficient maps portraying only a thin rim of restricted diffusion at the outer rim of the lesion, with facilitated diffusion centrally and at the outer edema. A: Diffusion-weighted images show a thin rim of increased diffusion at the outer rim of the lesion; B: The outer rim is hypointense on the corresponding apparent diffusion coefficient map images, indicating true restriction.

Figure 4 One hundred and forty-four millisecond single-voxel magnetic resonance spectroscopy was obtained from the left-enhancing centrum semiovale lesion. It showed a decrease in the choline/N-acetyl aspartate ratio along with mild lipid and lactate peaks.

Figure 5 There was only a T2-weighted linear signal intensity with magnetic resonance imaging obtained after nine months.
| Reference | Case number | Gender/age | Clinical presentation | Oligoclonal bands | Coexistence with injuries | Histopathological examination | Clinical progression |
|-----------|-------------|------------|-----------------------|-------------------|--------------------------|-----------------------------|---------------------|
| [7]       | 1           | F/37       | Monophasic            | NR                | NR                       | Y                           | SH                  |
|           | 2           | F/56       | Monophasic            | NR                | NR                       | Y                           | SH                  |
|           | 3           | M/42       | Monophasic            | NR                | NR                       | Y                           | SH                  |
|           | 4           | M/33       | Monophasic            | NR                | NR                       | SH                          |                     |
| [8]       | 1           | F/56       | Relapsing-Remitting   | Negative          | N                        | Y                           | MH                  |
|           | 2           | F/20       | Monophasic            | Negative          | N                        | N                           | CH                  |
|           | 3           | M/48       | Monophasic            | Positive          | Y                        | N                           | CH                  |
|           | 4           | M/38       | Monophasic            | Negative          | N                        | N                           | CH                  |
|           | 5           | F/15       | Monophasic            | Negative          | Y                        | N                           | SH                  |
| [9]       | 1           | F/29       | Relapsing-Remitting   | NR                | Y                        | N                           | MH                  |
|           | 2           | F/45       | Relapsing-Remitting   | Negative          | N                        | N                           | SH                  |
|           | 3           | M/26       | Progressive Primary   | NR                | N                        | N                           | SH                  |
|           | 1           | F/52       | Monophasic            | NR                | N                        | N                           | SH                  |
|           | 2           | M/31       | Monophasic            | NR                | N                        | N                           | CH                  |
|           | 3           | F/40       | Relapsing-Remitting   | NR                | Y                        | N                           | SH                  |
|           | 4           | M/31       | Monophasic            | NR                | N                        | N                           | CH                  |
|           | 5           | F/23       | Monophasic            | NR                | Y                        | N                           | SH                  |
|           | 6           | F/44       | Relapsing-Remitting   | NR                | Y                        | N                           | SH                  |
|           | 7           | F/43       | Relapsing-Remitting   | Negative          | Y                        | SH                          |                     |
|           | 1           | M/43       | Relapsing-Remitting   | Negative          | Y                        | N                           | MH                  |
|           | 1           | M/46       | Progressive Primary   | NR                | NR                       | Y                           | D                   |
|           | 2           | M/24       | Progressive Primary   | NR                | NR                       | Y                           | D                   |
|           | 3           | M/48       | Progressive Primary   | NR                | NR                       | Y                           | D                   |
|           | 4           | F/40       | Progressive Primary   | NR                | NR                       | Y                           | D                   |
|           | 5           | F/25       | Progressive Primary   | NR                | NR                       | Y                           | D                   |
|           | 6           | F/24       | Progressive Primary   | NR                | NR                       | Y                           | D                   |
|           | 1           | F/32       | Monophasic            | NR                | NR                       | Y                           | D                   |
|           | 2           | F/45       | Monophasic            | NR                | NR                       | Y                           | D                   |
|           | 3           | F/26       | Progressive Secondary | Negative          | N                        | Y                           | D                   |
|           | 1           | F/57       | Progressive Primary   | Positive          | Y                        | Y                           | D                   |
|           | 1           | F/54       | Progressive Primary   | Positive          | Y                        | Y                           | D                   |
|           | 1           | F/31       | Relapsing-Remitting   | NR                | Y                        | N                           | NR                  |
|           | 1           | M/28       | Relapsing-Remitting   | Negative          | NR                       | Y                           | D                   |
|           | 1           | F/32       | NR                    | NR                | NR                       | NR                          | NR                  |
|           | 1           | F/28       | Negative              | Negative          | NR                       | N                           | NR                  |
|           | 1           | F/52       | Monophasic            | Negative          | N                        | Y                           | SH                  |
|           | 1           | M/4        | Monophasic            | Negative          | N                        | N                           | MH                  |
|           | 1           | F/45       | Progressive Primary   | Negative          | N                        | N                           | MH                  |
|           | 2           | M/36       | Progressive Primary   | Negative          | N                        | N                           | LH                  |
|           | 1           | F/24       | Relapsing-Remitting   | NR                | Y                        | Y                           | D                   |
|           | 1           | F/34       | Monophasic            | NR                | Y                        | N                           | NR                  |
|           | 1           | M/NR       | Monophasic            | Negative          | N                        | SH                          |                     |
|           | 2           | F/38       | Progressive Primary   | Positive          | N                        | N                           | D                   |
|           | 3           | M/40       | Monophasic            | Negative          | N                        | N                           | SH                  |
|           | 1           | F/23       | Relapsing-Remitting   | Negative          | Y                        | N                           | MH                  |
|           | 1           | F/13       | Relapsing-Remitting   | Positive          | N                        | N                           | SH                  |
|           | 1           | F/27       | Relapsing-Remitting   | Negative          | N                        | Y                           | LH                  |
|           | 1           | F/37       | Monophasic            | NR                | NR                       | NR                          | MH                  |
|           | 1           | F/31       | Monophasic            | NR                | N                        | N                           | SH                  |
|           | 2           | F/58       | Monophasic            | NR                | Y                        | LH                          |                     |
|           | 1           | M/26       | Progressive Primary   | Positive          | N                        | Y                           | LH                  |
|           | 1           | F/17       | Relapsing-Remitting   | Positive          | N                        | N                           | MH                  |
Balo’s concentric sclerosis (BCS) was first described by Marburg in 1906, and related reports are numerous. In conclusion, in a patient with a mass lesion containing concentric rings, BCS diagnosis was reported by MRI imaging. As supported in previously reported clinical trials, BCS is not always a fatal disease and supports the definition that it may be a self-limiting disease. Although BCS is usually known to possess a fulminant demyelinating course, there are cases in the literature with favorable prognoses and occasionally cases with spontaneous remission. The unexpected finding of spontaneous remission without any treatment was noted in this case. A mass lesion with concentric rings that we determined more than nine months later were seen with a linear signal intensity without any treatment during MRI (Figure 5).

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