Original Article

Conglomerate Ring-Enhancing Lesions are Common in Solitary Neurocysticercosis and do not always Suggest Neurotuberculosis

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Abstract

Background and Purpose: Differentiating between neurocysticercosis (NCC) and neurotuberculosis has serious therapeutic implications and this distinction relies heavily on neuroimaging. Few case reports discuss the conglomeration of ring-enhancing lesions (RELs) in patients with solitary NCC. The aim of our study is to describe the imaging findings of conglomerate RELs in a cohort of patients with solitary NCC, emphasizing the frequency of conglomeration. **Materials and Methods:** This retrospective study included 100 patients with solitary NCC. Two neuroradiologists analyzed contrast-enhanced computed tomography (CT) images regarding morphology, enhancement pattern, location, number of lesions, and degree of perilesional edema. The solitary lesions were classified as solitary discrete RELs (SD-RELs) when a well-defined lesion was seen and solitary conglomerate RELs (SC-RELs) when two or more ring lesions or ring/rings plus disc lesions were present contiguously. Follow-up CT scans were evaluated for the resolution of lesions and surrounding edema. **Results:** Out of 100 patients, 42 were SD-RELs and 58 were SC-RELs. No statistically significant difference was found between both groups in terms of age of presentation, clinical presentation, lesion size and location, and degree of perilesional edema. Larger lesions (>10 mm) were more likely to show scolex and were associated with greater degree of edema in both subgroups. During follow-up, 13 patients had new lesions (SD-RELs-5, SC-RELs-8). In SD-RELs, follow-up lesions were in the same location in four patients and new location in one; and in SC-RELs, lesions were in the same location in seven and in new location in one case. **Conclusion:** Conglomeration of RELs is a common finding in patients with solitary NCC.

Keywords: Conglomerate ring lesions, neurocysticercosis, single ring-enhancing lesions

Introduction

Neurocysticercosis (NCC) is a common intracranial parasitic infections caused by the larval stage of *Taenia solium*.[1] Neuroimaging techniques, including computed tomography (CT) and magnetic resonance imaging (MRI), have revolutionized the diagnosis and management of this disease, by providing evidence of the number and topography of lesions, their stage of evolution, and the degree of inflammatory reaction of the host against the parasites.[2-4] While some imaging findings are highly suggestive of NCC, it is sometimes challenging to differentiate NCC from neurotuberculosis (nTB), especially in regions where both the diseases are endemic and can even coexist.[5] It is very important to differentiate these two entities in view of the difference in their management.[6] A degenerating NCC disappears or calcifies in short-term independent of the choice of therapy, whereas tuberculoma may progress and result in patient's poor outcome unless treated adequately with antitubercular treatment (ATT). Potential toxicity of ATT also remains a concern. Moreover, there is a high rate of intolerance to ATT with high dropout rates.[7]

Conglomerate ring-enhancing lesion (REL) is a radiological entity when two or more ring lesions are seen grouped together. These lesions are commonly reported in neurotuberculosis.[8-10] These lesions have also been described in nocardiosis,[11] cranial blastomycosis,[12] and NCC[13] as isolated case reports. Conglomerate RELs are best seen in MRI due to its better soft-tissue resolution and multiplanar capabilities. These are mostly missed and reported as single RELs on CT due to the thickness of the slices. However, recently, with the advent of multislice CT imaging, image reconstruction in thin 1–3 mm slices is done routinely. In the present study, the utility of thin-sections contrast-enhanced CT (CECT) scans in patients diagnosed to have solitary NCC has been reviewed. We also hypothesized that conglomerate RELs are more common in solitary NCC than previously reported and thus, the frequency of conglomeration of RELs was specifically evaluated.

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Materials and Methods

This was a retrospective study and included patients whose CT examinations were archived in our departmental picture archiving and communication system database. The Institutional Ethics Committee approved the study. Inclusion criteria were essentially the presence of the CT examination in the database (including CECT) and a clinical diagnosis of NCC, confirmed by stringent criteria as detailed elsewhere.[7] Exclusion criteria were patients whose CT examinations disclosed only calcified lesions or enhancing disc lesions, patients with multiple lesions in more than one location, patients who had received ATT, and patients without any follow-up imaging. Medical records of these patients were reviewed for clinical presentation and treatment history.

The solitary lesions were classified as solitary discrete RELs (SD-RELs) when a well-defined lesion was seen and solitary conglomerate RELs (SC-RELs) when two or more ring lesions or ring/rings plus disc lesions were present contiguously [Figure 1]. Among conglomerated ring lesions, the size and core of the largest ring lesion was evaluated. Thin-section CT scans were evaluated for the presence of scolex as eccentric hyperdensity and presence of conglomeration. The edema around the lesion was graded on a 5-point scale as (0) no edema, (1) edema <10 mm maximum distance around the lesion, (2) edema between 11 and 20 mm maximum distance around the lesion, (3) edema >20 mm maximum distance around the lesion, and (4) edema causing midline shift.

Follow-up CT scans were evaluated for the resolution of lesions and surrounding edema. The lesions were considered "resolved" if the follow-up CT study did not show the lesion. Persistence of the lesion was defined as evidence of lesion in CT scan (with or without contrast).

Statistical evaluation

We used the Statistical Package for the Social Sciences software (Strata version 14.0; StateCorp, Texas, USA) for statistical analyses. Univariate comparisons of categorical variables were performed using the Chi-square test/Fisher's exact test. Continuous variables were examined with the Student's *t*-test/Wilcoxon rank sum test. Statistical significance was two-tailed with $P < 0.05$.

Results

We identified 340 patients from our departmental archive with a diagnosis of NCC, of which175 patients had lesions in multiple locations or calcified lesions and were excluded from the study. Another 17 patients were excluded as they had been treated with antitubercular therapy. Another 48 patients in which RELs were most likely NCC but had no follow-up imaging were excluded. One hundred patients (65 men and 35 women) were included in the final analysis. The diagnosis of an NCC was confirmed in them on the basis of the definitive diagnostic criteria outlined previously.[14] The mean age was 22.7 ± 10.1 (SD) years (range 8–61 years).

Among the 100 patients, 42 were single discrete RELs (SD-REL) and 58 were single-conglomerate RELs (SC-RELs). Baseline demographic and clinical characteristics of included patients are outlined in Table 1.

Clinical features

In SD-REL, the clinical presentation was generalized seizures in 24 (57.1%), focal seizures with or without secondary generalization in 12 (28.6%), headache in 12 (28.6%), focal neurological deficits in 10 (23.8%), and recurrent vomiting in 2 (4.8%) patients. In patients with SC-REL, generalized seizures were the most common presentation and were present in 27 (46.5%) patients, focal seizures with/without secondary generalization in 20 (34.4%), headache in 16 (27.6%), focal neurological deficits in 8 (13.8%), and recurrent vomiting in 2 (3.4%) patients. Treatment history could be reviewed in 89/100 patients (SD-REL-39, SC-REL-50) [Table 1]. Antiepileptic treatment was given in 85/89 cases. Only 7/89 patients received anthelminthic drugs. No statistically significant difference was found between two groups in clinical features and treatment history [Table 1].

Imaging evaluation [Table 2]

CECT scans were available in all patients. In addition, 39 patients also had noncontrast CT for evaluation. Among these, 42 had SD-RELs (42%) and 58 had SC-RELs (58%).

Solitary discrete-ring-enhancing lesion

In CECT scan, the mean size of REL was 9 ± 2.24 mm (range: 5–14). The core of lesion was hypodense in 34/42 (80.9%) and isodense in 8/42 (19.4%) patients. The most common location of lesions was parietal lobe (42.9%), followed by frontal lobe (40.5%) and occipital lobe (7.1%). Scolex was visualized in 36 out of 42 patients (85.7%) [Figure 2]. Perilesional edema was Grade 2 in 54.8%, Grade 3 in 28.6%, and Grade 1 in 16.7%. None of the lesions had Grade 0 and Grade 4 perilesional edema.

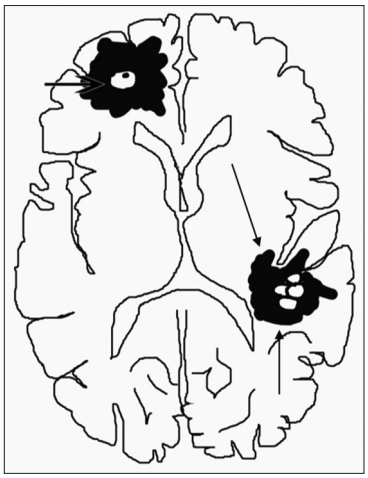

Figure 1: Schematic diagram of the brain shows solitary discrete ring-enhancing lesion with perilesional edema (short arrow) in the right frontal lobe and solitary conglomerate ring-enhancing lesions with perilesional edema (long arrows) in the left frontoparietal region

Table 1: Demographic and clinical profile

	Total	SD-REL	SC-REL	*P*
n	100	42	58	
Mean age (range)	22.7±7.8 (8-61)	22.4±11.9 (8-61)	22.8±8.6 (10-50)	0.350
Gender				
Male:female (ratio)	65:35 (0.53)	24:18 (0.75)	41:17 (0.41)	0.161
Clinical features (%)				
Generalized seizure	51 (51)	24 (57.1)	27 (46.5)	0.296
Focal seizure	32 (32)	12 (28.6)	20 (34.4)	0.532
Headache	28 (28)	12 (28.6)	16 (27.6)	0.914
Focal neurological deficit	18 (18)	10 (23.8)	8 (13.8)	0.198
Vomiting	4 (4)	2 (4.8)	2 (3.4)	0.99
Treatment (%)				
Antiepileptics only	78 (78)	37 (88.1)	41 (70.7)	0.206
Antihelminthics only	1 (1)	0	1 (1.7)	
Steroids only	3 (3)	1 (2.4)	2 (3.4)	
Antiepileptics + antihelminthics	5 (5)	0	5 (8.6)	
Antiepileptics + steroids	1 (1)	0	1 (1.7)	
Antiepileptics + steroids + antihelminthics	1 (1)	1 (2.4)	0	
Treatment history not available	11 (11)	3 (7.1)	8 (13.8)	

SD-REL=Solitary discrete ring-enhancing lesion, SC-REL=Solitary conglomerate ring-enhancing lesion

Solitary conglomerate-ring-enhancing lesion

Among the SC-RELs, the mean size of the largest ring lesion was 9 mm (range: 4–17) in CECT scans. The core of the largest ring lesion was hypodense in 54/58 (92.4%) and isodense in 4/58 (6.8%) patients. The most common location of lesions was frontal lobe (62.1%), followed by the parietal lobe (24%) and temporal lobe (6.9%). Scolex was visualized within at least one of the ring lesions in 52 out of 58 patients (89.7%) [Figure 3]. Perilesional edema was Grade 2 in 50%, Grade 3 in 27.6%, Grade 1 in 17.2%, and Grade 0 in 5.2% of cases. None of the lesions had Grade 4 perilesional edema.

Follow-up imaging [Tables 3 and 4]

Solitary discrete-ring-enhancing lesion

Follow-up CT scan was available in all 42 patients with a mean follow-up interval of 20.2 ± 18.5 months (range: 2.2–113.4 months) [Table 4]. The SD-RELs resolved completely in 9/42 (21.4%), decreased in size in 29/42 (69%), remained the same size in 3/42 (7.1%), and increased in size and became conglomerate in 1/42 (2.3%) patients [Figure 4]. The lesions showing complete resolution had longer mean follow-up interval (23.7 ± 8.2 months) compared to lesions showing decrease lesion size (20.7 ± 8 months) or the same lesion size (9.3 ± 22.5 months); however, these were not statistically significant [Table 3]. Only one patient showed increase in lesion size during short follow-up interval of 6.9 months.

The SD-RELs perilesional edema resolved completely in 25/42 (59.5%), decreased in size in 13/42 (30.9%), remained the same size in 3/42 (7.1%), and increased in 1/42 (2.3%) patients (44). The lesions showing complete resolution of edema had longer mean follow-up interval (26.3 ± 8.6 months) compared to lesions showing decrease (13.1 ± 5.6 months) or the same perilesional edema (4.3 ± 1.7 months); however, these were not statistically significant [Table 3]. Only one patient showed increase in perilesional edema during short follow-up interval of 6.9 months.

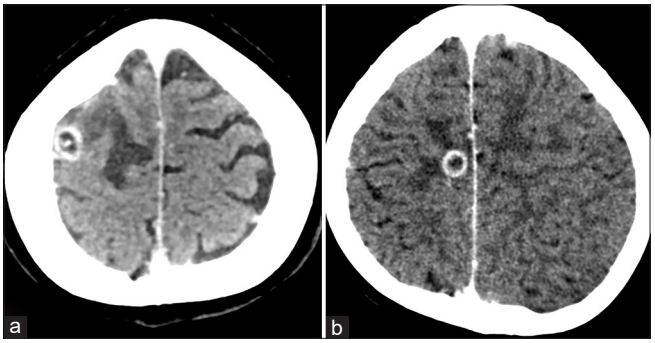

Figure 2: Solitary conglomerate ring-enhancing lesion. (a) A well-defined solitary discrete ring-enhancing lesion with eccentric scolex and Grade 3 perilesional edema in the right frontal convexity. (b) A well-defined solitary discrete ring-enhancing lesion without scolex and Grade 2 perilesional edema in the right frontal region. This lesion regressed completely during follow-up (not shown)

Solitary conglomerate-ring-enhancing lesion

The mean follow-up interval was 22.03 ± 18.1 months (range: 1.5–63.7 months). The SC-RELs resolved completely in 8/58 (13.8%), decreased in size in 41/58 (70.7%), remained the same size in 8/58 (13.8%), and increased in size in 1/58 (1.7%) patients. The lesions showing complete resolution had longer mean follow-up interval (27.6 ± 14.3 months) compared to lesions showing decrease lesion size (23.1 ± 5.7 months) or the same lesion size (12.8 ± 14.2 months); however, these were not statistically significant [Table 3]. Only one patient showed increase in lesion size during short follow-up interval of 4.5 months.

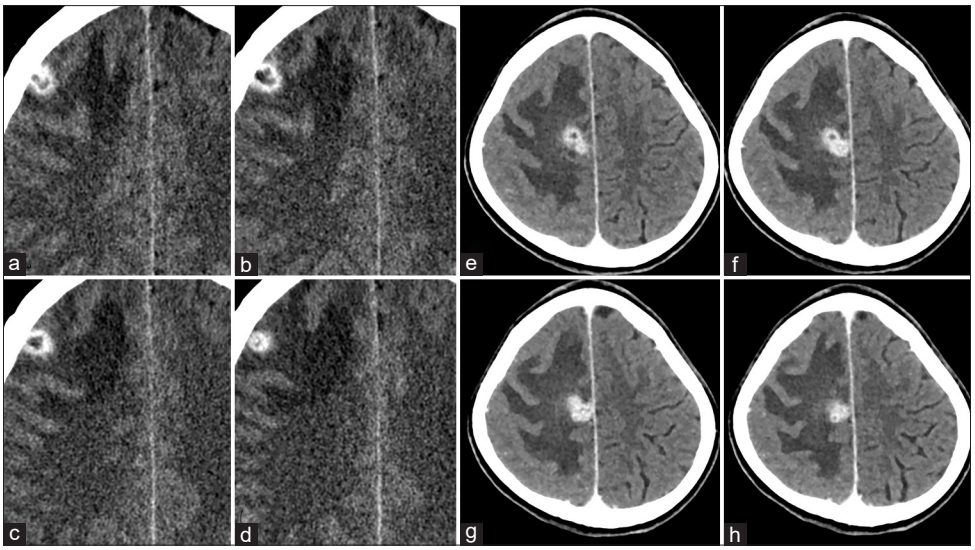

Figure 3: (a-d) Contrast-enhanced computed tomography head (2 mm) shows multiple conglomerate ring-enhancing lesions in the right frontal region with Grade 3 perilesional edema and scolex (d). (e-h) Contrast-enhanced computed tomography head (2 mm) multiple conglomerate ring-enhancing lesions in the right frontal region with Grade 3 perilesional edema and scolex (f)

Table 2: Imaging evaluation

	Total	SD-REL	SC-REL	*P*
Lesion size				
Mean (range)	9±2.27 (4-17)	9±2.24 (5-14)	9±2.31 (4-17)	0.997
Lesion Location (%)				
Frontal	53 (53)	17 (40.5)	36 (62.1)	0.164
Parietal	32 (32)	18 (42.9)	14 (24.1)	
Temporal	6 (6)	2 (4.8)	4 (6.9)	
Occipital	5 (5)	3 (7.1)	2 (3.4)	
Brain stem	3 (3)	2 (4.7)	1 (1.7)	
Thalamus	1 (1)	0	1 (1.7)	
Scolex (%)	88 (88)	36 (85.7)	52 (89.7)	0.549
Perilesional edema (%)				
0	3 (3)	0	3 (5.2)	0.653
1	17 (17)	7 (16.7)	10 (17.2)	
2	52 (52)	23 (54.8)	29 (50)	
3	28 (28)	12 (28.6)	16 (27.6)	
Core (%)				
Hypodense	88 (88)	34 (80.9)	54 (92.4)	0.067
Isodense	12 (22)	8 (19.4)	4 (6.8)	

SD-REL=Solitary discrete ring-enhancing lesion, SC-REL=Solitary conglomerate ring-enhancing lesion

The SC-REL perilesional edema resolved completely in 25/58 (43.1%), decreased in size in 28/58 (48.2%), remained the same size in 4/58 (6.8%), and increased in size in 1/58 (1.7%) patient [Table 3]. The lesions showing complete resolution of edema had longer mean follow-up interval (29.2 ± 18.6 months) compared to lesions showing decrease (12.2. ±6.4 months) or the same perilesional edema (5.5 ± 5.1 months); however, these were not statistically significant [Table 3]. Only one patient showed increase in perilesional edema during follow-up interval of 14.1 months.

Table 3: Follow-up imaging: Lesion size and perilesional edema evolution

	Total, *n* (%)	SD-REL, *n* (%)	SC-REL, *n* (%)	*P*
Lesion size				
Resolved	17 (17)	9 (21.4)	8 (13.8)	0.605
Decreased	70 (70)	29 (69)	41 (70.7)	
Same	11 (11)	3 (7.1)	8 (13.8)	
Increased	2 (2)	1 (2.4)	1 (1.7)	
Perilesional edema FU				
Resolved	50 (50)	25 (59.5)	25 (43.1)	0.369
Decreased	41 (41)	13 (31)	28 (48.3)	
Same	7 (7)	3 (7.1)	4 (6.9)	
Increased	2 (2)	1 (2.4)	1 (1.7)	

SD-REL=Solitary discrete ring-enhancing lesion, SC-REL=Solitary conglomerate ring-enhancing lesion, FU=Follow-up

Discussion

In NCC, the brain parenchyma is most commonly infested with high rates of cyst deposition occurring at junctions of gray and white matter. This is thought to be due to the accumulation of metacestodes in the small terminal blood vessels that converge here. During the pathogenesis of NCC, eggs become uncoated in the host intestinal tract liberating the enclosed larvae, oncospheres. These oncospheres penetrate the intestinal wall and are transported in the bloodstream to various tissues of the body, including the brain, eyes, skin, and muscles, where they are deposited.[15] Within these tissues, oncospheres differentiate and develop into metacestodes, which undergo multiple stages of development and establish as cysticerci. Most lesions are either solitary or multifocal ring lesions in different stages of evolution.[16]

Conglomerate lesions were thought to be unusual in NCC[17] but were commonly reported in neurotuberculosis.[8,10] On CECT,

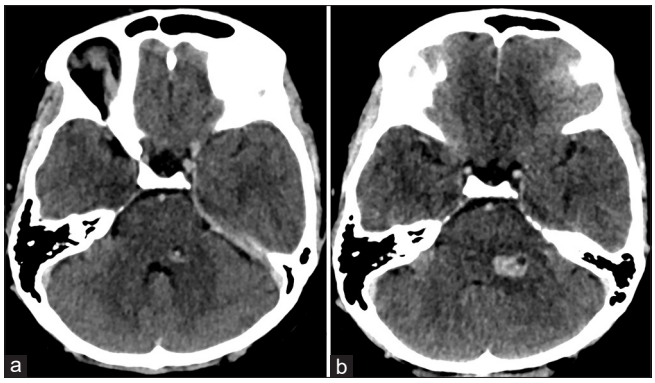

Figure 4: Contrast-enhanced computed tomography head (a) shows a solitary discrete ring-enhancing lesion with eccentric scolex in the dorsal pons. Follow-up computed tomography scan (b) done 7 months later shows evolution of lesion into conglomerate ring lesions with perifocal edema

Table 4: Follow-up imaging: Lesion size and perilesional edema evolution correlation to follow-up interval

	Mean FU interval (months)			*P*
	Total	SD-REL	SC-REL	
Mean FU interval (range) in months	21.2±18.2 (1.5-113.4)	20.2±18.5 (2.2-113.4)	22.03±18.1 (1.5-63.7)	0.779
Lesion size				
Resolved	25.5±7.08	23.7±8.2	27.6±14.3	0.700
Decreased	22.1±4.6	20.7±8	23.1±5.7	0.519
Same	11.8±10	9.3±22.5	12.8±14.2	0.838
Increased	5.7±14.8	6.9	4.5	0.317
Perilesional edema FU				
Resolved	27.8±5.5	26.3±8.6	29.2±18.6	0.356
Decreased	16.62±4.7	13.1±5.6	18.2±6.4	0.654
Same	21.2±3.6	4.3±1.7	5.5±5.1	0.721
Increased	10.5±46.1	6.9	14.1	0.317

SD-REL=Solitary discrete ring-enhancing lesion, SC-REL=Solitary conglomerate ring-enhancing lesion, FU=Follow-up

Rajshekar *et al*. described atypical "Type B" lesions having two confluent discs or rings or a combination in 4 out of 25[17] and 5 out of 43[17,18] biopsy-proven cases of NCC. Recently, Kumar *et al*.[19] reported "atypical" lesions having bilobed, septated, or disc configurations in 28.8% of cases using MRI. These atypical lesions often persist unresolved for a longer period and may even be associated with a higher risk of seizure recurrence because of the persistence of a calcified focus.[19] In our study, conglomerate lesions had two or more than two lesions mimicking tubercular lesions, so we preferred to call them SC-REL and not "atypical" NCC lesions. In our group, the SC-RELs are more common than SD-RELs. The higher incidence of SC-RELs in our study group may be explained by the fact that we evaluated thin-section (2 mm) CT scan slices on a radiological workstation. Rajshekar *et al*.[17,18] used minimum slice thickness of 4 mm which could have missed smaller lesions. In addition, proportion of patients with SC-RELs will be even higher when postcontrast MRI is used. On MRI, SC-RELs, "atypical" NCC, on MR frequently are known to have irregular ill-defined area of enhancement beyond the well-demarcated lesion.[20]

During follow-up scan, decrease and resolution in lesion size was seen in 69% and 21.4% of SD-RELs and 70% and 13.8% of SC-RELs, respectively. The lesions showing decrease in size or complete resolution had a longer follow-up interval compared to lesions with the same size or increase in lesion size. This is in concordance with the natural history of NCC where resolution is linked to the duration of follow-up. Interestingly, two patients showed increased in lesion size and perilesional edema; a phenomenon described earlier by Rajshekhar *et al*.[21]

The present study has some limitations: the diagnosis of NCC was determined, as done in most studies, according to the Del Brutto criteria[14,22] and not by histopathologic confirmation. A retrospective and transverse design and patients not consecutively included (due to characteristics of the above-cited inclusion criteria) are other limitations. In addition, there may be a selection bias as the study has been conducted at a tertiary referral center and there may be an overrepresentation of atypical/conglomerate ring lesions. Finally, we did not examine all patients with ring-enhancing lesions other than NCC. Prospective longitudinal studies, where possible with pathologic correlation, are encouraged to address some of the issues presented here and to advance the knowledge of such an important disease.

Conclusion

In conclusion, we could demonstrate that SC-RELs are more common than SD-RELs in solitary NCC. The presence of conglomeration of ring lesions in a single location of the brain raises the possibility of NCC and does not always indicate tuberculosis. Hence, the arbitrary use of ATT in patients with SC-RELs should be discouraged. Thin sections on CT should be done to look for the presence of an eccentric scolex. In patients without scolex, a close clinical and radiological follow-up may be recommended rather than rushing into starting ATT.

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Conflicts of interest

There are no conflicts of interest.

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