LEPTOMENINGEAL ENHANCEMENT IN SUSAC SYNDROME WITH POST CONTRAST FLAIR MRI

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OBJECTIVE: To assess the prevalence and the specificity of leptomeningeal enhancement (LME) in Susac syndrome (SS) using 3-tesla post-contrast T2-weighted fluid-attenuated inversion recovery (FLAIR) MRI compared to the most important differential diagnosis multiple sclerosis (MS) or clinical isolated syndrome (CIS).

METHODS: Two neuroradiologists blind to the clinical and ophthalmologic angiographic data independently examined MRIs and assessed LME and parenchymatous abnormalities. Initial MRI data from patients with SS (n = 9) were compared to data from patients with MS or CIS (n= 73). Multiple MRI (n= 53 for each patient with SS) were reviewed during the follow up (mean=61 month) and compared to clinical and retinal angiographic data evaluated by an independent ophthalmologist.

	Sex	Age	Neuro*	Hearing*	BRAO*	Relapse°	CSF Cell/ µl	CSF-protein	Treatment	Follow-up**	SUSAC criteria
1	F	19	Y	Y	Y	0	7	44	P, AVK, ASA, IVIG	28	Definite
2	F	44	Y	Y	N	0	0	31	ASA, IVIG	53	Definite
3	F	43	Y	N	Y	7	8	71	P, ASA, IVIG, CP	46	Definite
4	F	32	Y	N	Y	1	0	51	P, AVK, ASA, IVIG, CP, MM	72	Definite
5	F	65	Y	Y	Y	1	67	274	P, ASA, IVIG, CP	37	Definite
6	F	29	Y	Y	Y	2	2	99	P, ASA, IVIG, CP	31	Definite
7	F	37	Y	Y	Y	0	25	110	P, ASA, IVIG	67	Definite
8	M	32	N	N	Y	1	0	32	ASA, MM	56	Probable
9	F	37	Y	Y	Y	3	2	56	P, ASA, IVIG, CP, RTX	1	Definite

ASA: Acetylsalicylic Acid
AVK: Anti-Vitamin K
CP: Ciclophosphamide
IVIG: Intravenous Immune Globulin
MM: Mycophenolate Mofetil
P: prednisone
RTX: rituximab

*Clinical sign at the beginning of SS

° Number of relapse for each patient between 2011-2017

** Duration of follow-up between 1st studied MRI and the end of follow up period (month)

Table 1: Clinical Characteristics of patients with SS

Sex	F	50	(68%)
	H	23	(32%)
Age at diagnosis	Mean (range)	31.4	(18-56)
Medical history	MS	16	22%
	Inaugural ON	53	73%
	Recurrent ON	4	5%
EDSS at MRI	Mean (range)	2.15	(1-5)
Treatment	No	68	93%
	GA	2	3%
	IFN	2	3%
	MITX	1	1%
MS course duration (year)	Mean (range)	6.1	(0-24)
Final Diagnosis after MRI*	MS	56	(77%)
	CIS	17	(23%)

ON: Optic neuritis
GA: Glatiramer acetate
IFN: Interferon
MITX: Mitoxantrone

* MAGNIMS Criteria

Table 2: Clinical characteristics of the control group

RESULTS: LME was detected more frequently in SS cases (5/9) than in the comparison groups (6/73), (p=0.0016) and was more frequently infratentorial (5/9) vs. 0/73 (p < 0.0001) with multiple foci involved (5/9 vs. 0/73, p< 0.0001). There interobserver agreement regarding the main MRI findings was moderate to high (Cohen kappa range from 0.47 to 0.88).

		All 82	(%)	SS 9	(%)	Non SS 73	(%)	p	Kappa
Leptomeningeal									
LME FLAIR	Yes	12	(14)	5	(56)	6	(8)	p=0.0016	0.55
	No	71	(86)	4	(44)	67	(92)		
Number LME	≥3	5	(6)	4	(44)	0	(0)	p<0.001	0.79
	<3	78	(94)	5	(56)	73	(100)		
Brainstem LME	Yes	6	(7)	5	(56)	0	0%	p<0.001	0.88
	No	77	(93)	4	(44)	73	(100)		
T1 gado	Yes	9	(11)	4	(44)	4	(5)	p=0.004	0.47
	No	74	(89)	5	(56)	69	(95)		
Parenchymal									
FLAIR hyperintensity	Inflammatory	64	(77)	2	(22)	62	(85)	p<0.001	0.60
	Vascular	2	(2)	2	(22)	0	(0)		
	Unspecific	14	(17)	5	(56)	8	(11)		
	Absence	3	(4)	0	(0)	3	(4)		
CC	Yes	60	(73)	9	(100)	51	(70)	p=0.10	0.77
	No	22	(27)	0	(0)	22	(30)		
Form CC	Oval	50	(83)	2	(22)	48	(66)	p<0.001	0.74
	Punctate	10	(17)	7	(78)	3	(4)		
Localization CC	Median	5	(6)	5	(56)	0	(0)	p<0.001	0.73
	Paramedian	55	(66)	4	(44)	51	(70)		
	NA	23	(28)	0	(0)	22	(30)		
Cerebellar	No	33	(40)	6	(67)	26	(36)	p=0.14	0.61
	Yes	50	(60)	3	(33)	47	(64)		
T1 gd*	0	37	(44)	6	(67)	30	(41)	p=0.14	0.84
	1 to 5	33	(40)	1	(11)	32	(44)		
	> 5	13	(16)	2	(22)	11	(15)		

Table 3: MRI findings SS versus non SS

LME: Leptomeningeal Enhancement
CC: Corpus Callosum
T1 gd* : Post contrast gadolinium T1 weighted images

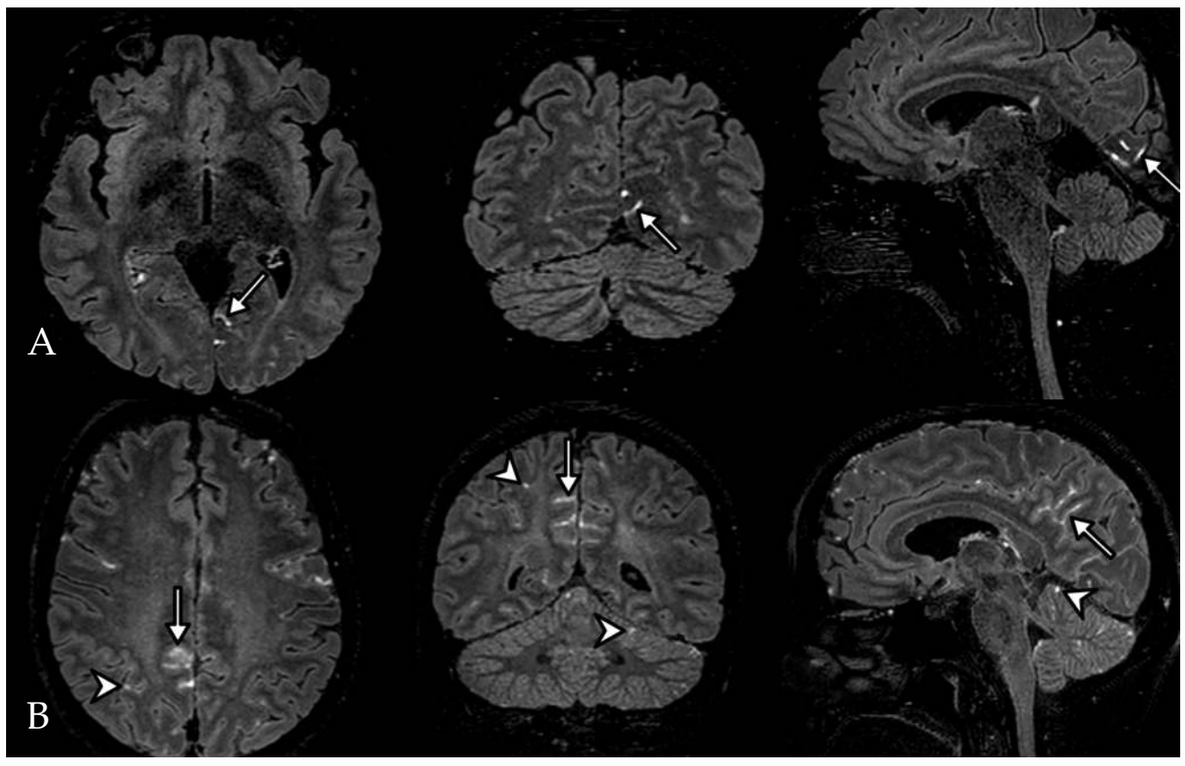

Figure 1: 3D-FLAIR post-contrast MR images in all 3 orthogonal planes
- **1A**: linear LME (white arrows ⟹) in **a multiple sclerosis** patient
- **1B:** punctiform (white arrowheads ≫) and linear (white arrows ⟹) patterns in a patient suffering from a **Susac Syndrom**. Note the presence of posterior fossa meningeal enhancement.

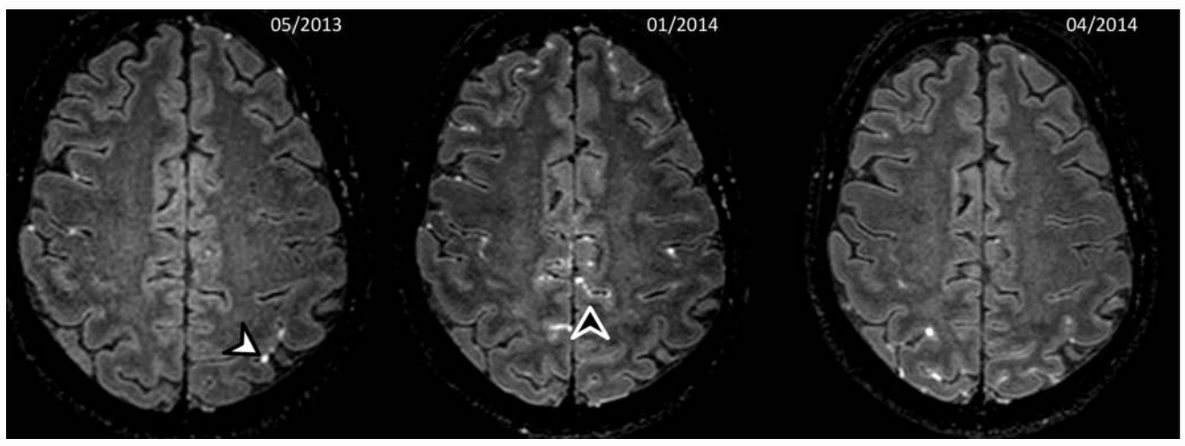

Figure 2: 1-year follow-up 3D-FLAIR post-contrast MR images in an axial plane showing a dissociated evolution of the leptomeningeal contrast-enhancements in a patient with a SS. Sequential MRIs show disappearance of the left parietal LME (white arrowhead ≫) and onset of new LME (black arrowhead ➤), both of them disappearing later in April 2014.

			n	(%)
Clinical	Relapse	Yes	17	(33.3)
		No	34	(66.7)
	Neurological		5	(29)
	Hearing loss		8	(47)
	Angiography	Total	14	(82)
		Occlusions	8	
		Vasculitis	6	
Radiological	LME	Yes	40	(75.5)
		No	13	(24.5)
	Number LME	0	13	(24.5)
		1-2	3	(5.7)
		3-10	9	(17)
		>10	28	(52.8)
	Cerebellar LME	Yes	33	(62.3)
		No	20	(37.7)
	T1 post contrast LME	Yes	30	(56.6)
		No	23	(43.4)
	LME evolution	Decreased	17	(38.6)
		Unchanged	10	(22.7)
		Increased	17	(38.6)
	Parenchymal evolution	Decreased	10	(22.7)
		Unchanged	16	(36.4)
		Increased	18	(40.9)

Table 4: Clinico-radiological data during SS follow-up

Significant association between (in a mixed-effect logistic model)
- Relapses and LME increase (OR 6.15; IC: 1.57-59.7; p = 0.01)
- Relapses and Parenchymal lesion increase (OR=5; IC: 1.34-37.71; p = 0.02)

CONCLUSION: LME occurs frequently in SS (56%-75% of MRI scans) with helpful characteristics for differential diagnosis (more than 3 loci and infratentorial involving). The increase of LME in the follow-up of a SS could be an additional marker of disease activity.