No. 1708

Bottom-of-sulcus dysplasia: MR imaging findings and predictive factors for seizure outcome after epilepsy surgery

58th ASNR in 2020

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Purpose

・Bottom-of-sulcus dysplasia (BOSD) is a newly recognized entity corresponding to small focal cortical dysplasia 2 (FCD2) located in the deep part of a single brain sulcus(1).

・Recognizing BOSD on MRI is crucial for referring the patient to surgery without complex presurgical workup such as invasive monitoring(2).

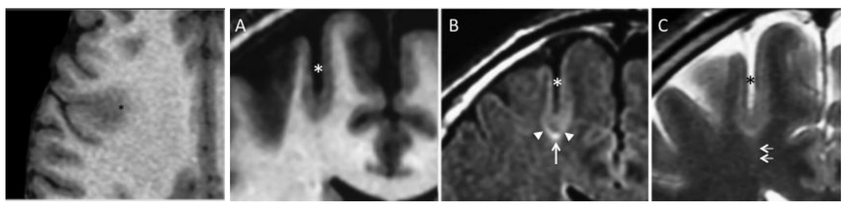
・BOSD is known for its excellent outcome of seizure control after complete resection resection(3).

・Our aim is to share characteristic MR imaging findings and predictive factors of postoperative outcome in BOSD.

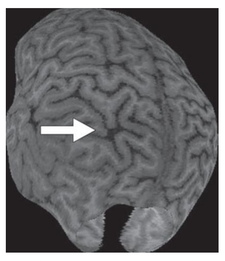
Imaging findings of BOSD

・As all FCDs, BOSD can be recognized by the following MR signs.

・BOSD is unique in its limited location of the bottom of one sulcus.



Gray-white junction blurring (black asterisk) | cortical thickening unusual sulcus (white asterisk) | subcortical T2 hyperintensity (arrow & arrowheads) | transmantle sign (double arrows)



abnormal gyral pattern (arrow)

(Mellerio, et al. AJNR 2012) (Hofman, et al. AJR 2011)

BOSD and postoperative outcome

・BOSD emphasizes the major role of MRI for detection of this surgically remediable lesion.

・In previous studies, completeness of resection have been reported as the main predictive factor of better outcome after surgery(4).

・FCD2 histopathology, younger age at surgery, unilobular lesion, short duration of epilepsy, and temporal lobe location were also reported as contributing factors for better outcome, but they are under debating.

Methods

We investigated imaging aspects and their relation with postoperative outcome of FCD2 including BOSD.

For imaging aspects,

・We investigated 52 histologically proven lesions of FCD2 with minimal 2 years follow-up seizure outcome assessment which showed positive MRI.

・ We compared MR imaging findings in BOSD and FCD2. For comparison, diagnosis of BOSD was made for 37 lesions after 5 cases exclusion due to judgement mismatch by 2 neuroradiologists.

For assessment of postoperative outcome,

・Engel classification and medication status after surgery were scored.

・We investigated difference of outcome between positive and negative group for each MRI finding.

・In addition, we divided FCD2 lesions into 4 types to assess whether size and distribution of lesions are related to outcome..

Findings and Discussion

・In our study, frontal lobe location, transmantle sign, and sulcus anomaly or dilatation were more frequent in BOSD compared to FCD2.

・In type analysis, typical BOSD showed the best postoperative outcome.

・The bottom of sulcus limited lesions (typical BOSD) showed high scores and the gyrus limited lesions showed low scores both in Engel and medication scores.

・Both size and distribution of lesions were related to outcome, and distribution factor significantly contributed to better outcome in Engel score.

Summary

・BOSD has excellent postoperative outcome and detection of BOSD by its characteristic MR imaging findings can lead to curative surgery.

・In our study, it was suggested that the bottom of sulcus limited distribution without the gyrus involvement might be related to better outcome in BOSD.

・We should pay attention to small dysplasia at the bottom of a sulcus in epilepsy patients, especially lesions with transmantle sign and sulcus anomaly/dilatation.

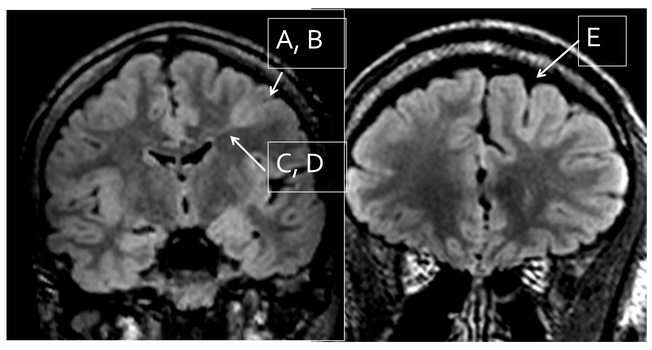
(1) Hofman PA1, Fitt GJ, Harvey AS, et al. Bottom-of-sulcus dysplasia: imaging features. Am J Roentgenol. 2011; 196(4): 881-5.
(2) Chassoux F, Rodrigo S, Semah F, et al. FDG-PET improves surgical outcome in negative MRI Taylor-type focal cortical dysplasias. Neurology. 2010; 75(24): 2168-75.
(3) Harvey AS, Mandelstam SA, Maixner WJ, et al. The surgically remediable syndrome of epilepsy associated with bottom-of-sulcus dysplasia. Neurology. 2015; 84(20): 2021-8.
(4) Fauser S, Essang C, Altenmüller DM, et al. Long-term seizure outcome in 211 patients with focal cortical dysplasia. Epilepsia. 2015 Jan;56(1):66-76.

[Comparison between BOSD and FCD2]

We compared location and frequency of 5 MRI signs in 32 BOSD and 47 FCD2, and assessed their relation with prognosis after surgery.

•Location
-BOSD: 87.5% were in frontal lobe.
-FCD2: 75% were in the frontal lobe.

• 5 MRI signs in BOSD/FCD2

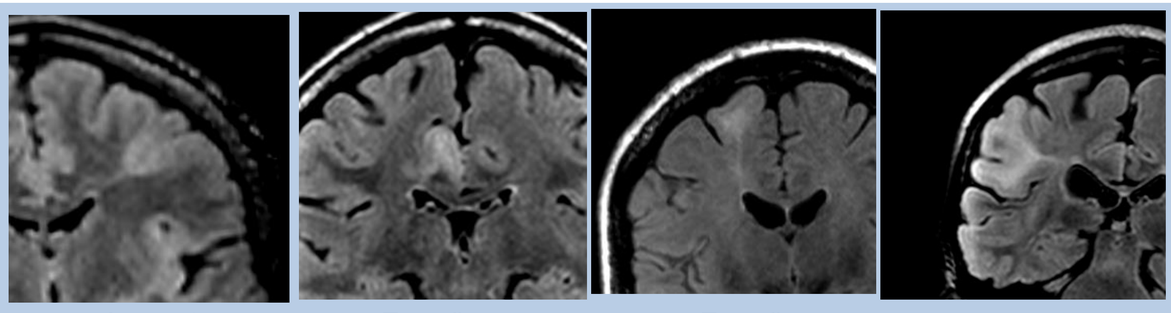


A: cortical thickening (91% / 91%)
B: WM-GM blurring (97% / 94%)
C: WM signal change (81% / 83%)
D: transmantle sign (59% / 47%)
E: sulcus anomaly or dilatation (44% / 34%)

＊Diagnosis of BOSD was made by 2 neuroradiologists. (concordance rate: 90%)
＊Significant outcome difference was not detected between positive and negative groups for each MRI sign.

[Different types of BOSD/FCD2]

We divided FCD2 into 4 types based on distribution of lesions.
Type1: small FCD2 located at the deep part of a single sulcus (= typical BOSD)
Type2: FCD2 involving both the bottom of sulcus and the adjacent gyrus
Type3: FCD2 involving the gyrus without the bottom of sulcus
Type4: Large FCD2 extending over one sulcus .



Type 1 (typical BOSD) | Type 2 | Type 3 | Type 4

[Outcome scores]

<Engel score>
Class I: Free of disabling seizures -IA (6), IB (5), IC (4), ID (3)
Class II: Rare disabling seizures (“almost seizure-free”) -IIA-IID (2)
Class III: Worthwhile improvement -IIIA, IIIB (1)
Class IV: No worthwhile improvement -IVA-IVC (0)
<Medication score>
Stopped (2), decreased (1), same (0), compared to medication before surgery

[Results: types and outcome after surgery]

1. Types and Engel classification & medication scores in 4 types

＊Type1(typical BOSD) showed the best Engel score with highest rate of Engel IA..

＊Type3 showed significant low Engel score compared to type 1, 2, and 4.
(p< 0.05 with Mann-Whitney U test with Bonferroni correction)

type	1	2	3	4	total
n	26	12	3	11	52
Engel classification I	25 (96%)	11(92%)	2 (67%)	9 (82%)	47 (90%)
I A (Engel score 6)	22 (85%)	8 (67%)	1 (33%)	6 (55%)	37 (71%)
non I A (Engel score 3-5)	3 (11%)	3 (25%)	1 (33%)	3 (27%)	10 (19%)

type	1	2	3	4	
n	26	12	3	11	52 (total)
Engel score	5.73*	5.08	3.33*	4.91	5.27 (average)

type	1	2	3	4	
n	24	10	3	10	47 (total)
medication score	1.13	0.9	0.67	0.8	0.98 (average)

2. Types and Engel classification & medication scores in 3 groups

＊Type1(typical BOSD) showed significant high Engel score compared to type3;4. (p< 0.05 with Kruskal Wallis multiple comparison)

type	1	2	3+4	
n	26	12	14	52 (total)
Engel score	5.73*	5.08	4.57*	5.27 (average)

type	1	2	3+4	
n	24	10	13	47 (total)
medication score	1.13	0.9	0.77	0.98 (average)

3. Analysis based on size and distribution

＊Distribution factor significantly contributed to better outcome in Engel score.
(p< 0.05 with Mann Whitney U test with Bonferroni correction)

size factor (within 1 sulcus vs. over 1 sulcus)

type	1+2+3	4	
n	41	11	52 (total)
Engel score	5.37	4.91	5.27 (average)

type	1+2+3	4	
n	37	10	47 (total)
medication score	1.03	0.8	0.98 (average)

Distribution factor (only bottom vs. including gyrus)

type	1	2+3+4	
n	26	26	52 (total)
Engel score	5.73*	4.81*	5.27 (average)

type	1	2+3+4	
n	24	23	47 (total)
medication score	1.13	0.83	0.98 (average)