

Distribution of Intra-Thalamic Injury According to Nuclei and Vascular Territories in Children with Term Hypoxic-Ischemic Injury

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- No conflicts of interest to declare



Background



Hypoxic-ischemic injury (HII) affects 1-8 per 1000 live births with a mortality rate of approximately 15-25%.

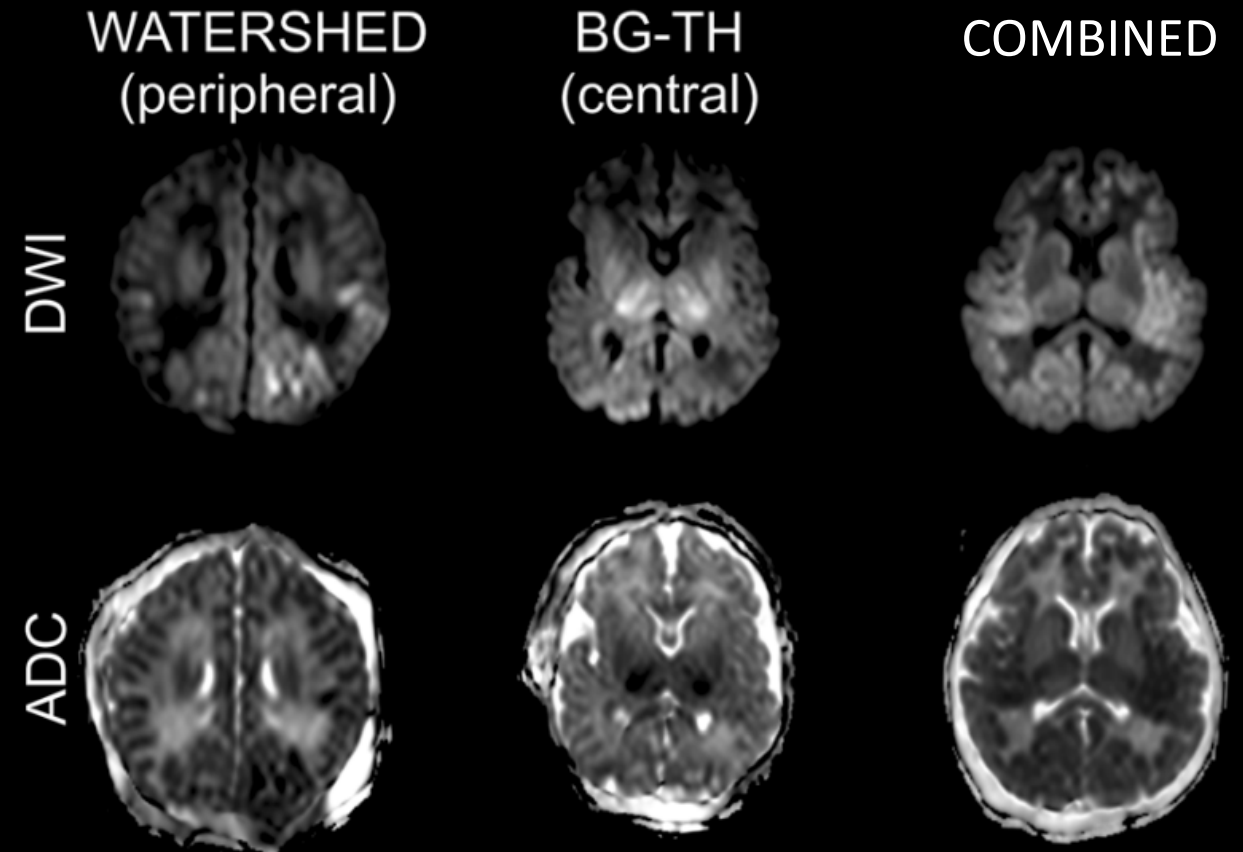
The differing imaging **patterns of injury**, and clinical outcomes vary with duration, timing, and severity of the insult.

Three major imaging patterns described:

- Basal ganglia thalamus [BGT]
- Watershed [WS]
- Combined [BGT/WS]

Cognitive, language, motor, and sensory impairments have been linked to **thalamic injury** in the setting of HII.

Patterns of HIE



Lakatos, A., Kolossváry, M., Szabó, M. et al. Neurodevelopmental effect of intracranial hemorrhage observed in hypoxic ischemic brain injury in hypothermia-treated asphyxiated neonates - an MRI study. BMC Pediatr 19, 430 (2019)

Background

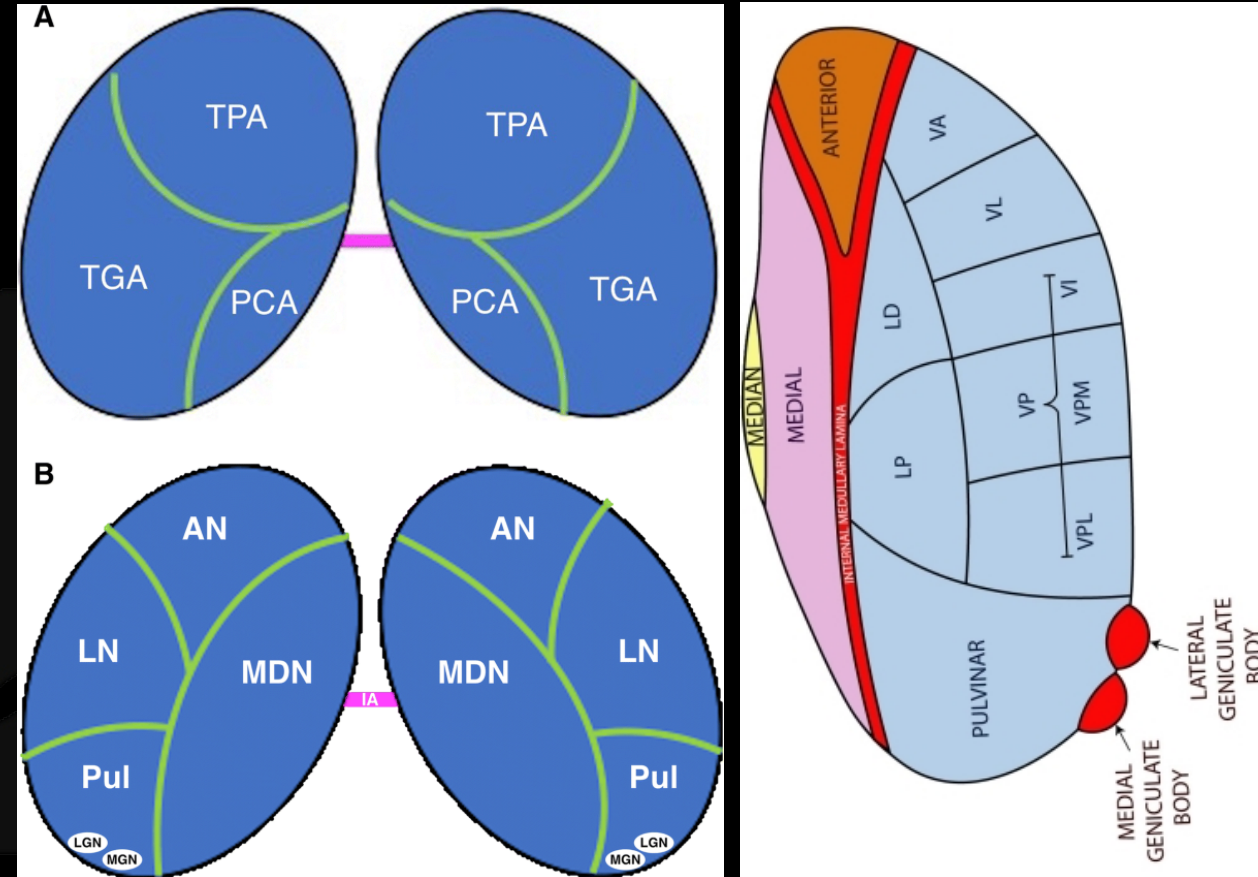


Thalami can be subdivided into anatomic and functional regions.

Ventrolateral thalamus injury in HII described in BGT pattern

Lack information on how other regions affected:

- intra-thalamic nuclei
- thalamic vascular areas



Tuttle, C., Boto, J., Martin, S. et al. Neuroimaging of acute and chronic unilateral and bilateral thalamic lesions. Insights Imaging 10, 24 (2019)

Purpose



To characterize the intra-thalamic injury in patients with different radiological HII patterns, based on nuclear distribution, vascular territories involved, and subjective radiological predominance.



Retrospective, multi-center study

Inclusion:

- Children with cerebral palsy allegedly due to HII
- Brain MRI with at least axial T2 / FLAIR
- Thalamic involvement in MRI report.

Exclusion criteria:

- Significant motion artifact
- Incomplete visualization of the thalami.



Pediatric neurologist with >20 years experience blinded to clinical information

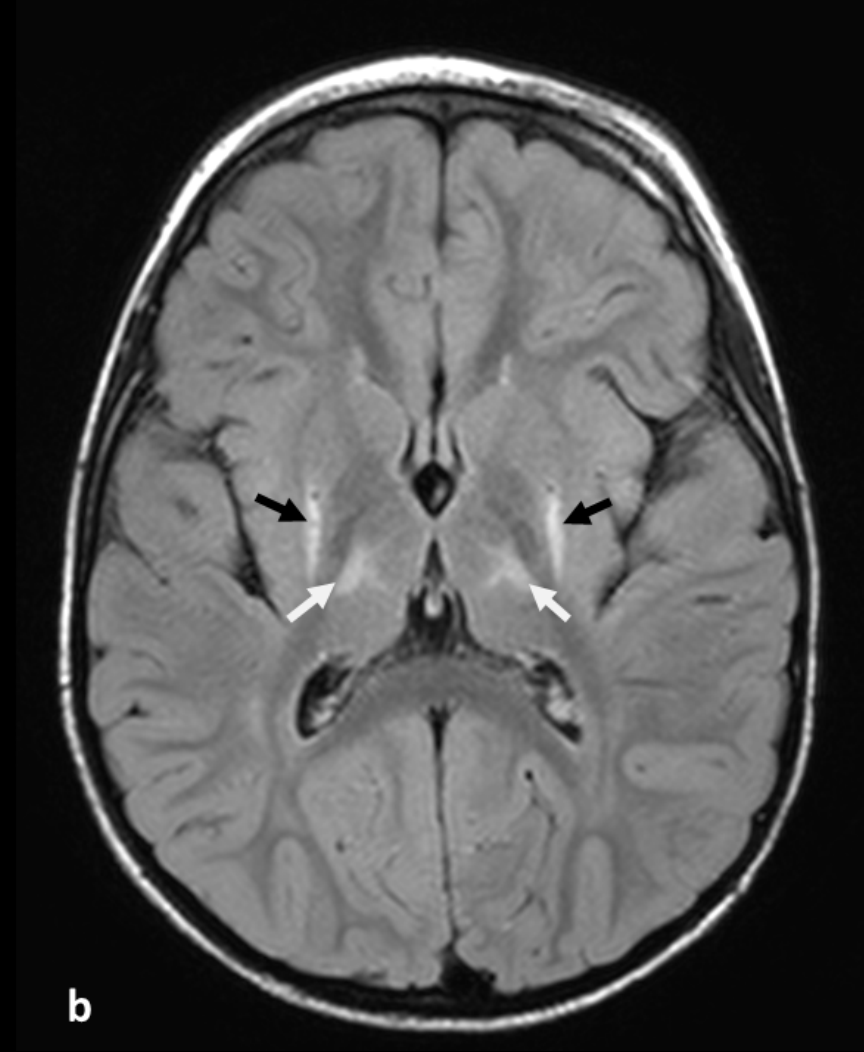
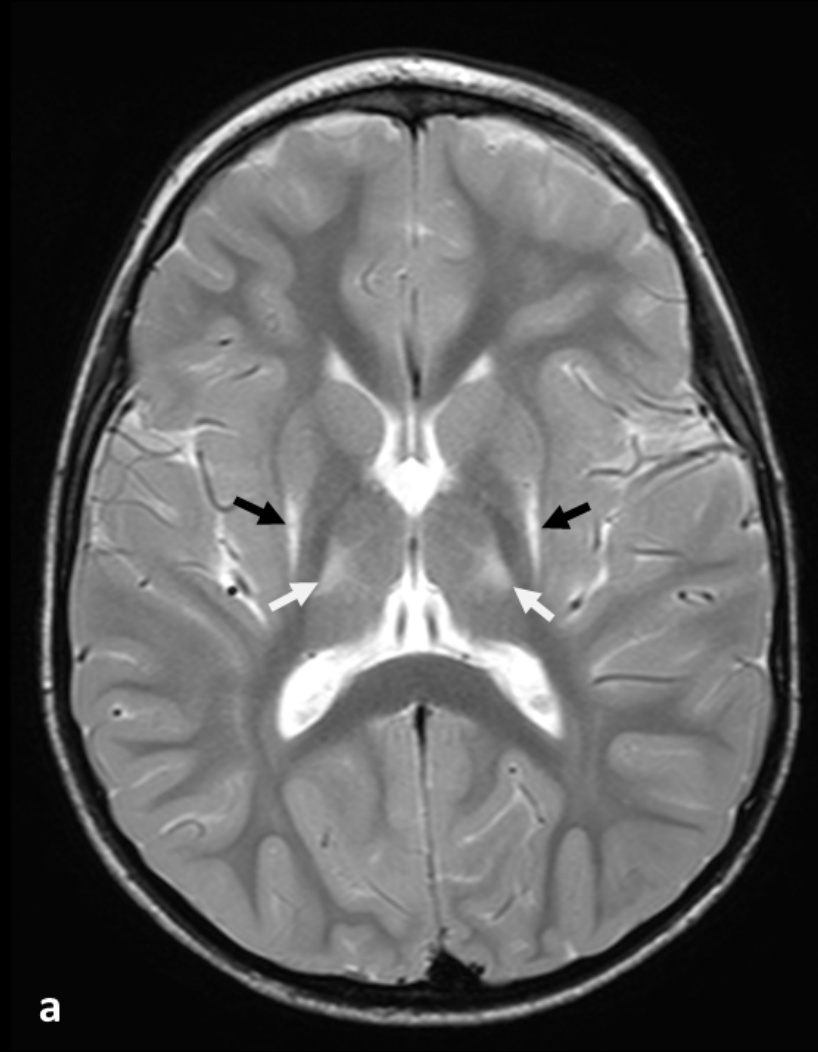
HII groups according to the pattern of injury

- Basal-Ganglia-Thalamus [BGT]
- Watershed [WS]
- Combined [BGT/WS]

Methods



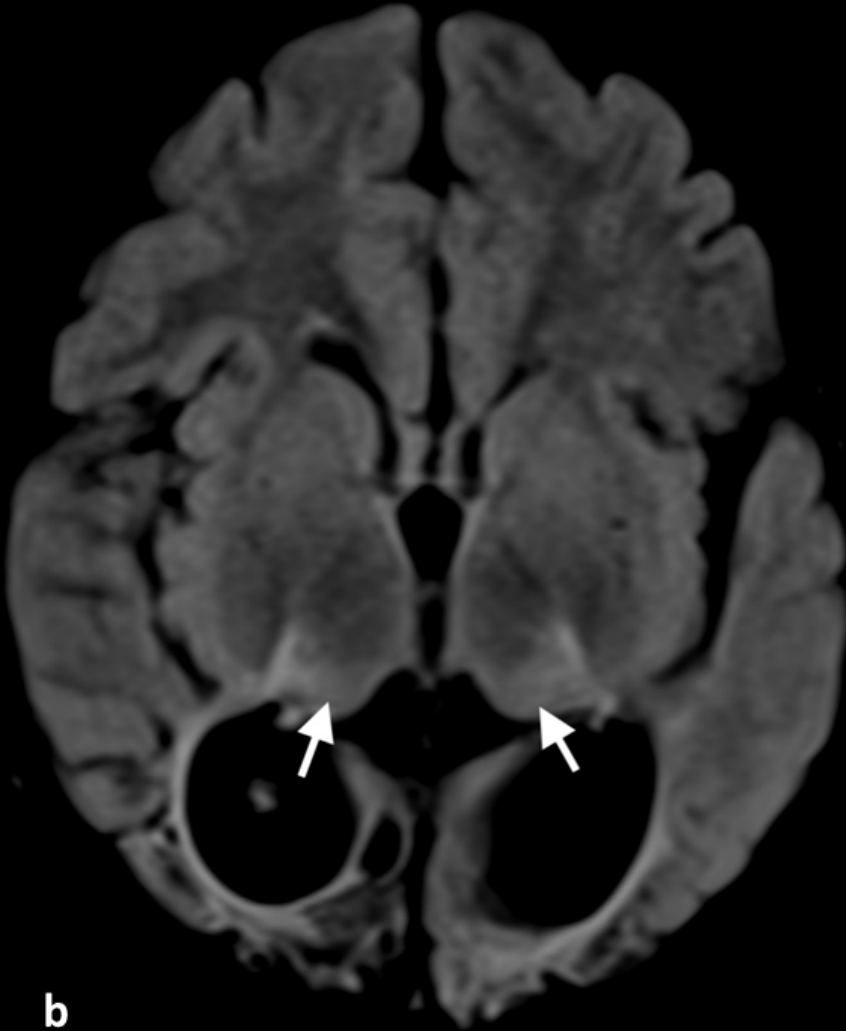
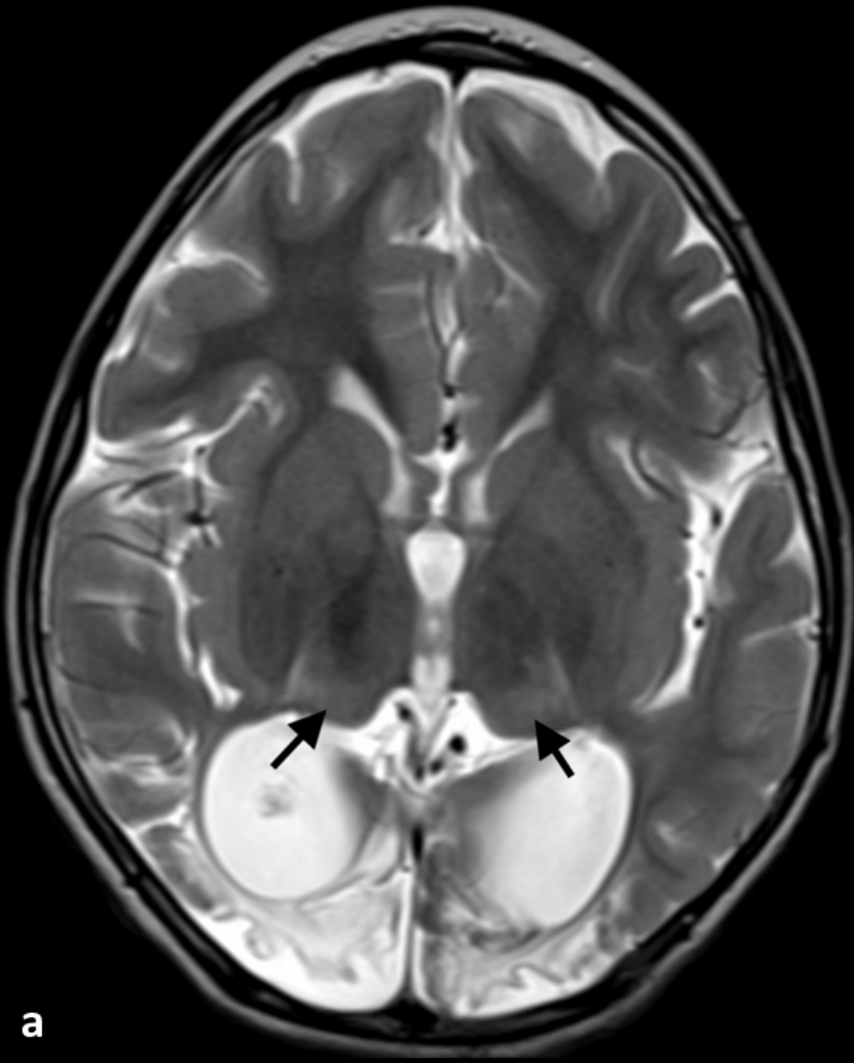
Basal ganglia thalamus
[BGT] pattern



Methods



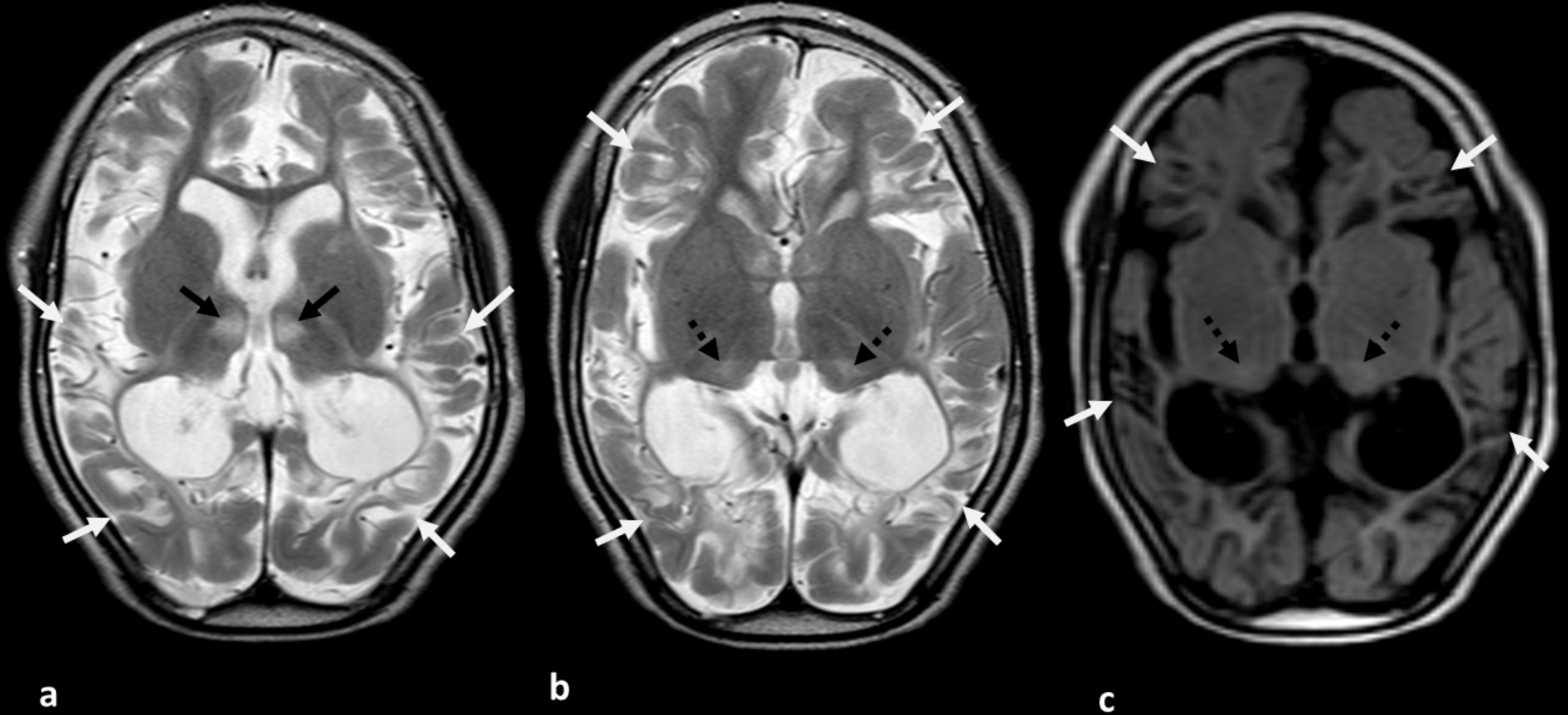
Watershed pattern



Methods

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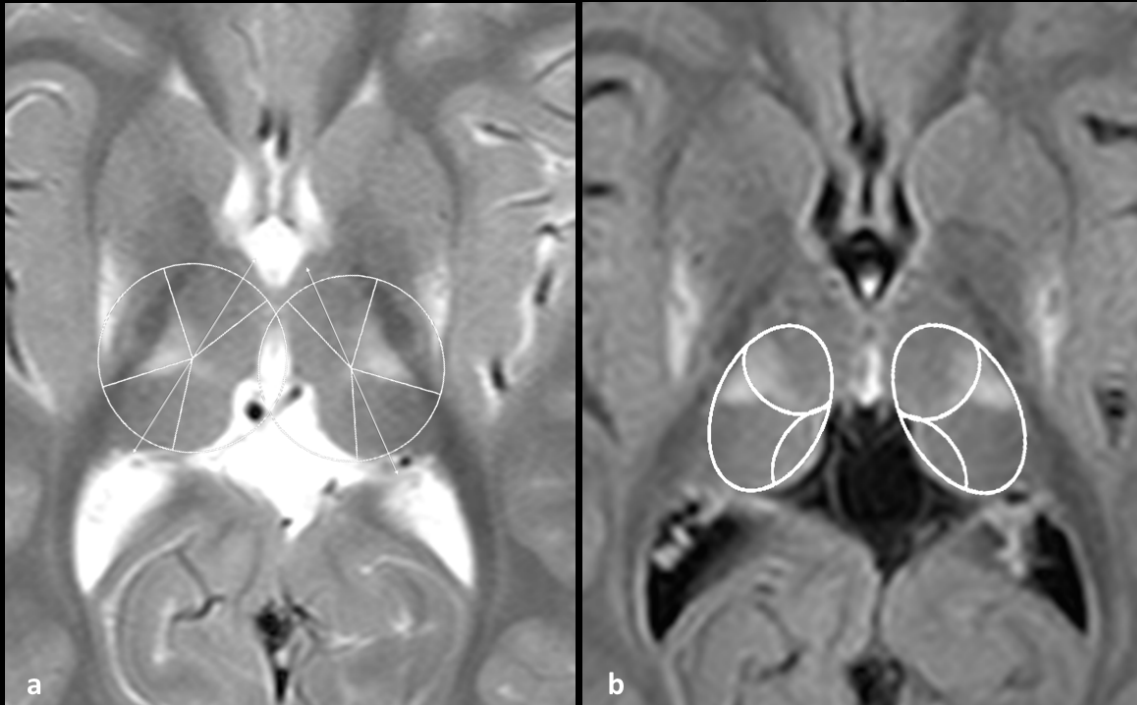
Combined [BGT/WS]
pattern



Methods



We created custom tools for nuclear regions and vascular territories:



Data collected by a trained clinical researcher, blinded to the MRI reports:

Intra-thalamic nuclei

Medial

Ventrolateral

Anterior

Pulvinar

Vascular territories

Thalamoperforating

Thalamogeniculate

Posterior choroidal

Subjective radiological distribution predominance

Whole/near-whole

Central

Anterior

Posterior

Lateral

Medial

Chi-square for associations between HII groups

Results



We evaluated **128 children** (mean age 7.35 ± 3.6 years).

Lesions were bilaterally symmetric in 127/128 (99.2%) cases

HII group	Number (%)
BGT	53 (41.4%)
WS	33 (25.8%)
BGT/WS	42 (32.8%)
Total	128 (100%)

Intra-thalamic nuclei	# (%)
AN	36 (28.1%)
VLN	85 (66.4%)
MN	56 (43.8%)
PN	72 (56.3%)
All	25 (19.5%)

Vascular territories	# (%)
TPA	69 (53.9%)
TGA	119 (93%)
PCA	61 (47.7%)
All	26 (20.3%)

Subjective radiological distribution predominance	# (%)
Whole/near-whole	23 (18%)
Central	18 (14.1%)
Anterior	3 (2.3%)
Posterior	36 (28.1%)
Lateral	41 (32%)
Medial	7 (5.5%)

Association between hypoxic-ischemic injury MRI patterns and intra-thalamic groups and combinations.

Intra-thalamic nuclei	BGT [OR (CI)]	p-value	WS [OR (CI)]	p-value	BGT/WS [OR (CI)]	p-value
AN	0.62 (0.28-1.39)	0.246	0.27 (0.09-0.84)	0.018*	3.98 (1.76-8.97)	0.001*
VLN	2.41 (1.09-5.31)	0.027*	0.17 (0.07-0.41)	<0.001*	1.99 (0.87-4.58)	0.101
MN	0.50 (0.24-1.04)	0.061	0.66 (0.29-1.49)	0.321	3.03 (1.41-6.52)	0.004*
PN	0.20 (0.09-0.43)	<0.001*	6.49 (2.31-18.25)	<0.001*	1.41 (0.67-3.00)	0.367
AN+VLN	0.72 (0.31-1.67)	0.442	0.35 (0.11-1.08)	0.060	2.91 (1.26-6.72)	0.010*
AN+MN	0.46 (0.19-1.10)	0.078	0.33 (0.11-1.03)	0.047	4.64 (1.99-10.82)	<0.001*
AN+PN	0.35 (0.13-0.95)	0.034*	0.46 (0.15-1.44)	0.175	4.68 (1.89-11.58)	<0.001*
VLN+MN	0.61 (0.28-1.34)	0.220	0.53 (0.21-1.35)	0.180	2.73 (1.24-5.99)	0.011*
VLN+PN	0.44 (0.19-1.01)	0.050	0.61 (0.24-1.58)	0.305	3.35 (1.49-7.51)	0.003*
MN+PN	0.33 (0.15-0.75)	0.006*	0.94 (0.41-2.17)	0.884	3.20 (1.47-6.95)	0.003*
AN+VLN+MN	0.60 (0.25-1.46)	0.260	0.41 (0.13-1.28)	0.116	3.12 (1.32-7.40)	0.008*
AN+VLN+PN	0.38 (0.14-1.02)	0.049	0.49 (0.15-1.54)	0.213	4.22 (1.69-10.52)	0.001*
AN+MN+PN	0.35 (0.13-0.95)	0.034*	0.46 (0.15-1.04)	0.175	4.68 (1.89-11.58)	<0.001*
VL+MN+PN	0.38 (0.15-0.93)	0.030*	0.59 (0.22-1.59)	0.294	3.86 (1.67-8.91)	0.001*
AN+VLN+MN+PN	0.38 (0.14-1.02)	0.049	0.49 (0.15-1.54)	0.213	4.22 (1.69-10.52)	0.001*



Results



Association between hypoxic-ischemic injury MRI patterns and thalamic vascular supply.

Vascular supply territories	BGT [OR (CI)]	p-value	WS [OR (CI)]	p-value	BGT/WS [OR (CI)]	p-value
TPA	1.37 (0.68-2.79)	0.382	0.18 (0.07-0.44)	<0.001*	3.01 (1.36-6.66)	0.005*
TGA	0.54 (0.14-2.12)	0.371	1.38 (1.24-1.55)	0.067	0.59 (0.15-2.31)	0.441
PCA	0.18 (0.08-0.40)	<0.001*	2.41 (1.06-5.45)	0.033*	2.75 (1.28-5.92)	0.008*
TPA+TGA	1.25 (0.62-2.53)	0.531	0.25 (0.10-0.62)	0.002*	2.37 (1.11-5.05)	0.024*
TPA+PCA	0.31 (0.12-0.82)	0.015*	0.41 (0.13-1.28)	0.116	5.70 (2.32-14.01)	<0.001*
TGA+PCA	0.19 (0.08-0.41)	<0.001*	2.74 (1.21-6.23)	0.014*	2.36 (1.11-5.02)	0.024*
TPA+TGA+PCA	0.35 (0.13-0.95)	0.034*	0.46 (0.15-1.44)	0.175	4.68 (1.88-11.58)	<0.001*

Results



Association between hypoxic-ischemic injury MRI patterns and subjective radiological distribution predominance.

Subjective radiological distribution predominance	BGT [OR (CI)]	p-value	WS [OR (CI)]	p-value	BGT/WS combination [OR (CI)]	p-value
Whole/near-whole	0.56 (0.21-1.48)	0.238	0.55 (0.17-1.76)	0.310	2.73 (1.09-6.85)	0.029*
Central	1.5 (0.55-4.08)	0.425	0.32 (0.07-1.47)	0.125	1.36 (0.48-3.82)	0.554
Anterior	0.7 (0.62-7.95)	0.774	0.97 (0.93-1.00)	0.302	4.25 (0.37-48.26)	0.206
Posterior	0.36 (0.15-0.86)	0.018*	11.57 (4.61-29.02)	<0.001*	0.24 (0.09-0.67)	0.004*
Lateral	3.85 (1.76-8.41)	0.001*	0.22 (0.70-0.67)	0.004*	0.66 (0.29-1.50)	0.322
Medial	0.22 (0.03-1.89)	0.134	0.46 (0.05-4.00)	0.475	5.68 (1.05-30.6)	0.025*



Conclusions



- There are significant differences between MRI-based HII groups in their intrathalamic distribution, based on both nuclear groups and vascular territories.
- This was also evident through a less strict, subjective examination of the thalamic lesional predominance without the predefined tools.
- These patterns may depend on both the severity and duration of the insult (pathogenic mechanisms), as well as other superimposed factors that can potentiate damage.

Thank you!

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