Pediatric Neurology 50 (2014) 18–25

Contents lists available at ScienceDirect

Pediatric Neurology

journal homepage: www.elsevier.com/locate/pnu

Original Article

Hippocampal Volume and Memory Performance in Children With Perinatal Stroke

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ABSTRACT

BACKGROUND: Pediatric neurologists and neonatologists often are asked to predict cognitive outcome after perinatal brain injury (including likely memory and learning outcomes). However, relatively few data exist on how accurate predictions can be made. Furthermore, although the consequences of brain injury on hippocampal volume and memory performance have been studied extensively in adults, little work has been done in children. **METHODS:** We measured the volume of the hippocampus in 27 children with perinatal stroke and 19 controls, and measured their performance on standardized verbal and non-verbal memory tests. **RESULTS:** We discovered the following: (1) As a group, children with perinatal stroke had smaller left and right hippocampi compared with control children. (2) Individually, children with perinatal stroke demonstrated 1 of 3 findings: no hippocampal loss, unilateral hippocampal loss, or bilateral hippocampal volume loss compared with control children. (3) Hippocampal volume inversely correlated with memory test performance in the perinatal stroke group, with smaller left and right hippocampal volumes related to poorer verbal and non-verbal memory test performance, respectively. (4) Seizures played a significant role in determining memory deficit and extent of hippocampal volume reduction in patients with perinatal stroke. **CONCLUSIONS:** These findings support the view that, in the developing brain, the left and right hippocampi preferentially support verbal and nonverbal memory respectively, a consistent finding in the adult literature but a subject of debate in the pediatric literature. This is the first work to report that children with focal brain injury incurred from perinatal stroke have volume reduction in the hippocampus and impairments in certain aspects of declarative memory.

Keywords: hippocampus, memory, stroke, pediatrics, epilepsy

Pediatr Neurol 2014; 50: 18-25

Introduction

Ample evidence demonstrates that adults who sustain damage to the hippocampus and other medial temporal lobe structures incur profound, life-long declarative (ie, episodic and semantic) memory impairment.[1-4] One consistent finding has been that patients with left-sided brain lesions tend to be more impaired at verbal memory tasks, whereas patients with right-sided brain lesions tend to be more impaired at nonverbal memory tasks.[5-13] Similarly, evidence from functional magnetic resonance imaging, positron emission tomography imaging, and behavioral testing of adult patients with epilepsy suggests that the left hippocampus is more involved in verbal memory tasks whereas the right hippocampus is move involved in nonverbal memory tasks.[6,10,12-19] Furthermore, patients with bilateral hippocampal lesions are much more impaired than patients with unilateral hippocampal lesions, such that patients with bilateral lesions may have difficulty holding jobs and managing their own affairs whereas patients with unilateral lesions often learn to function independently with the use of compensatory strategies.[9,20]

In contrast to this extensive literature in adults, comparatively little work has been done to investigate the

Article History:
Received June 25, 2013; Accepted in final form August 27, 2013
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http://dx.doi.org/10.1016/j.pediatrneurol.2013.08.029

TABLE 1.
Demographics, characteristics, and lesion/neurological information

Patient/Control	Age, y	Sex	Race	IQ	Seizures	Hemiparesis	Lesion Side	Lesion Site	Lesion Severity
Patient									
1	16	M	C	101	No	No	Right	FTPOSW	5
2	14	M	C	121	No	No	Right	FP	5
3	15	F	C	118	No	No	Left	F	2
4	13	M	C	71	Yes	Yes	Right	FTPBW	5
5	7	M	C	83	Yes	Yes	Left	FTPOSGBW	5
6	7	F	C	95	Yes	No	Right	FS	2
7	8	M	C	104	No	Yes	Right	B	2
8	8	M	H	114	No	Yes	Left	F	4
9	10	M	C	89	Yes	No	Right	FSG	3
10	12	F	C	58	Yes	Yes	Right	FTPOSB	5
11	11	F	C	82	No	Yes	Left	M	4
12	8	F	H	100	Yes	No	Left	P	4
13	14	F	C	82	Yes	No	Left	P	4
14	14	F	C	75	No	Yes	Left	T	4
15	7	F	H	63	Yes	Yes	Left	FTPSBW	5
16	14	M	C	99	Yes	Yes	Right	FTP	5
17	12	M	H	86	No	Yes	Left	FPSG	5
18	12	M	C	135	No	No	Left	PS	4
19	8	M	C	68	Yes	Yes	Right	FTPSMBW	5
20	6	F	C	66	Yes	Yes	Left	P	4
21	8	F	C	62	Yes	Yes	Right	FTPOSBW	5
22	9	M	C	89	Yes	No	Left	FP	5
23	9	F	C	86	Yes	Yes	Right	FTPSGBW	5
24	14	F	C	57	No	No	Left	FTP	5
25	13	M	C	112	No	No	Left	FS	4
26	11	F	C	101	No	Yes	Left	TPSW	5
27	12	M	C	67	Yes	Yes	Right	FTPSGBW	5
Control									
1	10	M	H	107	No	No	Normal	None	
2	8	F	C	107	No	No	Normal	None	
3	8	M	C	112	No	No	Normal	None	
4	7	M	C	117	No	No	Normal	None	
5	13	M	AA	90	No	No	Normal	None	
6	8	F	C	113	No	No	Normal	None	
7	12	F	H	120	No	No	Normal	None	
8	10	F	C	113	No	No	Normal	None	
9	7	F	C	131	No	No	Normal	None	
10	13	M	C	133	No	No	Normal	None	
11	10	M	C	122	No	No	Normal	None	
12	8	M	A	135	No	No	Normal	None	
13	8	M	A	135	No	No	Normal	None	
14	7	F	C	128	No	No	Normal	None	
15	9	F	C	106	No	No	Normal	None	
16	9	M	C	113	No	No	Normal	None	
17	14	F	C	107	No	No	Normal	None	
18	8	F	C	121	No	No	Normal	None	
19	7	F	C	110	No	No	Normal	None	

Abbreviations:
A = Asian
AA = African American
B = Broca area
C = Caucasian
F = Frontal
G = Basal ganglia
H = Hispanic
M = Thalamus
O = Occipital
P = Parietal
S = Subcortical
T = Temporal
W = Wernicke area
Severity scores range from 0 to 5 (see Materials and Methods for details).