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Pediatric Intracarotid Sodium Amytal (ISA) Procedure in Determiination of Cerebral Dominance for Language and Memory Function - Preliminary Prport

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Pediatric Intracarotid Sodium Amytal (ISA) Procedure in Determination of Cerebral Dominance for Language and Memory Function - Preliminary Report

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The intracarotid sodium amytal (ISA) procedure, introduced by Wada in 1949, is used to identify cerebral dominance for language and memory function in preparation for epilepsy surgery such as unilateral temporal lobectomy. Five cases with complex partial seizure, four boys and one girl, were included in this study. Their ages of onset ranged from 3 to 11 years old. Frequency of seizure ranged from 2 to 3 fits per month to 50 to 60 fits per day. Four cases were right-handers, one case was left-hander. All of them had normal intelligence. MRI scan of three cases showed positive findings. In continuous EEG/video monitoring, epileptogenic foci were over right temporal region in four cases, and over left temporal region in one case. ISA procedure revealed left speech dominance in four cases and right speech dominance in one case. As to cerebral dominance for memory function, there were no significant lateralization regarding both verbal and nonverbal memory in four cases. Four cases, three with left speech dominance and one with right speech dominance, finally received unilateral temporal lobectomy with partial removal of hippocampus contralateral to the speech dominant hemisphere . There were neither aphasia nor amnesia noted postoperatively, which gave indirect evidence to the accuracy of ISA procedure. Severity of seizure reduced markedly in these four cases after operation.

Key words : intracarotid sodium amytal (ISA) procedure, epilepsy, temporal lobectomy, complex partial seizure, lateralization, aphasia, amnesia

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The intracarotid sodium amytal (ISA) procedure, used to identify cerebral dominance for language and memory function, is an integral part of preoperative evaluation for epilepsy surgery [1,2] The results concerning language dominance are especially helpful in planning the surgical approach to patients with posterior temporal or frontal epileptogenic focus, in whom the determination of language dominance has a direct impact on the type and extent of surgery [3]. The procedure typically involved injecting certain amount of sodium amytal into the internal carotid artery via catheter following a transfemoral approach which results in 4 to 5 minutes' ipsilateral hemispheric anesthesia. During this short period of time, patients are presented with multiple cognitive tasks to evaluate the speech and language capabilities of the non-injected hemisphere [2], and normally hemispheric memory function are tested as well [4].

This study will illustrate cases with complex partial seizure, who were enrolled for detailed preoperative study including intracarotid sodium amytal procedure before they received unilateral temporal lobectomy and partial removal of hippocampus.

MATERIAL AND METHOD

Five cases with history of complex partial seizure for years were included in this study. They were scheduled for possible unilateral temporal lobectomy due to intractability of their seizure in spite of regular major anticonvulsant treatment for at least two years. Detailed preoperative evaluation including MRI and/or CT scan, continuous EEG/ video monitoring, PET scan and neuropsychologic testing were performed first. Intracarotid sodium amytal (ISA) procedure was then scheduled to localize cerebral dominance for language and memory function before temporal lobectomy to minimize postoperative risk of aphasia and amnesia.

To be familiar with these patients and to assess their cognitive ability so that right items could be chosen for ISA procedure, examiner had several interviews with patients beforehand. The day before ISA procedure, patients received a bedside pretest to assess their baseline performance level which could be used for comparison with the result of ISA procedure.

Routine monitors were placed and a brief period of unconsciousness was induced with intravenous propofol during femoral artery catheterization. After patient regained consciousness, examiner had brief conversation with patient to make sure patient had returned to his (her) usual neurologic status. Internal carotid artery of the same side with epileptogenic foci was chosen to be injected first. Moment before the drug was injected, the patient lay flat on his back with both arms raised. He was asked to count from 1 to 20 and without warning the radiologist injected certain amount of sodium amytal through the catheter, located at internal carotid artery for 3 to 4 seconds. Within seconds, there were dramatic changes in behaviors. Patient's contralateral arm fell to the bed with a flaccid paralysis but ipsilateral arm was not affected. Patient stopped counting and can not answer simple question if speech dominant hemisphere was injected. Memory performance was then tested by asking the patient to memorize a number of common objects; including 7 verbal materials and 7 nonverbal materials, presented in quick succession. 5 minutes after his flaccid arm had regained normal muscle strength, patient was requested to recall the test items that were presented to him (her) during ISA procedure to assess recent memory function. Another side intracarotid sodium amytal test was then administered with same sequence one hour later.

CASE REPORT

Case 1

Chen X, an 8 years old boy with normal birth and developmental history, was a left hander. He began to suffer from complex partial seizure since

6 and 1/2 years old. Twitching movement of left limbs was noted during attack with loss of consciousness sometimes. Frequency of seizure was 50 to 60 times per day. Due to intractability of seizure in spite of regular anticonvulsant treatment for two years, he was scheduled to receive preoperative evaluation for epileptic surgery. Preoperative CT and MRI scan were both negative. Continuous EEG/video monitoring suggested seizure onset from right mid-temporal region. WISC-R revealed FIQ 90, VIQ 92, PIQ 89. His language development was within normal limit. ISA procedure revealed left speech dominance. There was no significant lateralization regarding verbal memory. As to nonverbal memory, right hemisphere contributed slightly more than left hemisphere. Patient finally underwent right temporal lobectomy with partial removal of hippocampus in Jan. 1993. There was no clinical aphasia or amnesia postoperatively. Reduction of seizure severity was greater than 50% at 17 months after operation.

Case 2

Yang XX, an 8 years old boy with normal birth and developmental history, was a right hander. He began to suffer from complex partial seizure since 3 years old. Loss of consciousness was noted during attack with secondary generalization sometimes. Frequency of seizure was at least 7 to 8 times per month. Due to intractability of seizure in spite of regular anticonvulsant treatment for five years, he was scheduled to receive preoperative evaluation for epileptic surgery. Preoperative CT and MRI scan were both negative. Continuous EEG/video monitoring suggested epileptogenic foci over left posterior temporal region. WISC-R revealed FIQ 126, VIQ 115, PIQ 135. Language development was within normal limit. There was hypometabolism over left temporal region in PET scan. ISA procedure revealed right speech dominance. There was no significant lateralization regarding verbal memory. As to nonverbal memory, left hemisphere contributed slightly more than right hemisphere. Patient finally received left temporal lobectomy and partial removal of hippocampus in Feb. 1993. There was no clinical aphasia or amnesia noted postoperatively. Reduction of seizure severity was greater than 90% in this case at 16 months after operation.

Case 3

Su XX, a 10 years old boy with normal birth and developmental history, was a right hander. He began to suffer from complex partial seizure since 6 years old. Loss of consciousness was noted during attack with secondary generalization. Frequency of seizure was 3 to 4 times per week in spite of regular medical treatment for four years. Surgical treatment was scheduled due to intractability of seizure. Preoperative MRI scan revealed arachnoid cyst over right anterior and medial temporal region. Continuous EEG/video monitoring suggested a partial seizure disorder with multifocal epileptogenic foci and secondary generalization, the former is most active over right mid and posterior temporal region followed by left temporal region. WISC-R revealed FIQ 87, VIQ 78, PIQ 101. He also had mild language delay. There was hypometabolism over right temporal region in PET scan. ISA procedure revealed left speech dominance and left memory dominance regarding both verbal and nonverbal memory. Patient finally received right partial temporal lobectomy and removal of major hippocampus in Nov. 1993. No clinical aphasia or amnesia was noted. He has been seizure free after operation and at 7 months follow-up.

Case 4

Ye XX, a 17 years old girl with normal birth and developmental history, was a right hander. She began to suffer from complex partial seizure since 8 years old. Aura included dizziness and palpitation were noted before attack and followed by loss of consciousness with secondary generalization sometimes. Frequency of seizure was 2 to 3 fits

per month in spite of regular medical treatment for nine years. She was admitted for preoperative evaluation. MRI scan showed left medial temporal sclerosis. Continuous EEG/video monitoring suggested a partial seizure disorder with secondary generalization, most probably arising from the left temporal region. WISC-R revealed FIQ 85, VIQ 73, PIQ 101. Her language development was within normal limit. Impaired verbal and nonverbal memory were noted in neuropsychologic testing which implied bilateral temporal dysfunction. There was hypometabolism over left temporal region in PET scan. ISA procedure revealed left speech dominance. There was no significant lateralization regarding verbal memory. As to nonverbal memory, right hemisphere contributed slightly more than left hemisphere. Also , severe impairment of memory function during anesthesia of left hemisphere was noted, which implied right temporal dysfunction . In case that right temporal lobe can not support memory function needed in daily life and since the frequency of seizure was not really impressive (2 to 3 fits per month only), she was recommended to continue medical treatment for a while.

Case 5

Wong XX, a 13 years old boy with normal birth and developmental history, was a right hander. He began to suffer from complex partial seizure since 11 years old. Twitching movement of right limbs with loss of consciousness was noted during attack. Frequency of seizure was once per day in spite of regular medical treatment for two years. Due to intractability of his seizure, he was scheduled to receive surgical treatment. Preoperative MRI scan revealed small mass lesion over anterior basal region of right temporal lobe. Continuous EEG/video monitoring suggested partial seizure disorder probably arising from the right temporal region. WISC-R revealed FIQ 121, VIQ 116, PIQ 122. PET scan showed epileptogenic focus over right inferior temporal region. ISA procedure revealed left speech dominance. Right hemisphere contributed more than left hemisphere to verbal memory. There was no significant lateralization regarding nonverbal memory. Patient finally received right partial temporal lobectomy with removal of hippocampus in Mar. 1994.No clinical aphasia or amnesia was noted. He has been seizure free after operation and at 2 months follow-up.

DISCUSSION

Although language center is usually located in the left hemisphere, a small percentage of people,mostly left-handed, have language represented in the right hemisphere [5]. According to Rasmussen and Milner, right speech dominance was noted in 15% of left handers and only 4% of right handers. Intracarotid sodium amytal procedure was originally designed to assess hemispheric lateralization of speech and language function in patients with potential abnormal language representation, it has been extended to assess the memory function in patients going to receive unilateral temporal lobectomy as well so as to minimize the risk of postoperative amnesia [6]. Also, ISA procedure is an invasive procedure and does carry potential risks of neurological complication [4,7,8].

The pediatric patient must be alert and able to communicate with examiners so that multiple cognitive tasks can be presented to the patient during the ISA procedure [3]. To avoid pain or possible panic reaction during femoral line placement which will result in unpleasant experience and poor cooperation, a brief period of unconsciousness is necessary by using an ultrashort-acting anesthetic agent, propofol, for femoral arterial catheterization [3]. It is proved to have a short recovery time which will not interfere with the ISA procedure thereafter.

Although ISA procedure has been widely administered for several decades, the method for determining the dosage of sodium amytal is still controversial. Some medical centers do increase dos-

age with the weight of the patient, but most centers do not [9]. There are many factors that will affect patient's response to this drug. In general, determination of the dosage of sodium amytal by 2.0mg/Kg will provide plenty of time to assess pediatric patient's language and memory performance under normal circumstance.

Ideally, the test should be performed bilaterally [3-5]. In pediatric patients, the side with epileptogenic focus should be injected and studied first in case that patient can not tolerate bilateral procedures due to poor cooperation. Under that circumstance, we still get enough information to predict the potential risk of postoperative aphasia and amnesia [10].

All the cases in this study had had history of complex partial seizure for at least two years. They were scheduled to receive preoperative evaluation due to intractability of seizure in spite of regular major anticonvulsant treatment. Epileptogenic foci located over temporal region of the hemisphere contralateral to the speech dominant hemisphere in four cases. Under that circumstance, surgeon can resect areas with epileptogenic focus as much as necessary without the concern of damaging areas with vital function. If it happens that epileptogenic foci locate over temporal region of the speech dominant hemisphere, the extent of surgery has to be more conservative in order to preserve areas with vital function even if some epileptogenic foci are left. Besides, if memory function over the hemisphere contralateral to the hemisphere with epileptogenic foci is noted to have obvious impairment during ISA procedure, operation will not be optimal in case that memory function left after unilateral temporal lobectomy can not support the demand in daily life. This was the reason why case 4 continue to receive medical treatment after ISA procedure. ISA procedure not only has a direct impact on the extent of surgery but also has impact on the decision making in undergoing operation or not.

There was no clinical aphasia noted in our four cases who received temporal lobectomy contralateral to the speech dominant hemisphere which gave indirect evidence of the accuracy of ISA procedure. The first three cases were of age younger than 10 years old. A brief period of unconsciousness was induced with intravenous propofol during femoral line placement to reduce unpleasant emotional reaction which will interfere with ISA procedure thereafter. The other two patients were older and more cooperative so that line placement were done under local anesthesia. All of our five cases completed bilateral procedures without difficulties.

Case I was a left hander with speech dominant hemisphere located over left side. The other four cases were right handers. According to series of Rasmussen and Milner [5], the incidence of left speech dominance in right hander was 96%. If ISA procedure was not done preoperatively in case 2, his speech dominant hemisphere would suppose to be at the same side with epileptogenic foci. Under that circumstance, the extent of surgical resection had to be very conservative so that areas with vital function would not be damaged and hance probably would affect the therapeutic effect of operation. Since ISA procedure suggested that his speech dominant hemisphere was contralateral to the hemisphere with epileptogenic focus, surgeon could resect areas with epileptogenic foci as much as necessary without concem of damaging vital areas. This case had 90% reduction in seizure severity after operation.

In summary, to avoid postoperative aphasia and amnesia in elective surgery for epileptic disorder [11], intracarotid sodium amytal procedure should be performed preoperatively to localize the side of cerebral dominance for speech and memory function so that surgeons can avoid to damage areas with vital functions[5]. The results of our four cases who underwent unilateral temporal lobectomy finally did provide indirect evidence of the accuracy of intracarotid sodium amytal procedure.

Table: . Summary of clinical manifestations and laboratory findings in this study

CaseNo.	1	2	3	4	5
Age of onset	6 1/2	3	6	8	11
Seizure type	CPS	CPS	CPS	CPS	CPS
Frequency	50-60/D	7-8/M	34/W	2-3/M	1/D
Handpreference	L	R	R	R	R
MRI	-	-	+	+	+
PET+	*	L temporal	R temporal	L temporal	R temporal
EEG	R temporal	L temporal	R temporal	L temporal	R temporal
FIQ	90	126	87	85	121
VIQ	92	1]5	78	73	116
PIQ	89	135	101	101	122
Language development	N	N	mild delay	N	*
Speechdominance	L	R	L	L	L
Memory dominance					
Verbal	L=R	L=R	L	L=R	R>L
Nonverbal	R>L	L>R	L	R>L	R=L
Operation	R temporal	L temporal	R temporal	*	R temporal
Follow-up period	17 M	16 M	7 M	*	2 M
Outcome	>50% reduction	>90% reduction	free	*	free

+ Hypometabolic area in PET scan

* Not performed

Abbreviation: CPS= complex partial seizure; MRI= magnetic resonance imaging; PET= positron emission tomography; EEG= electroencephalography; FIQ= full intelligence quotient; VIQ= verbal intelligence quotient; PIO= performance intelligence quotient

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以兒童頸動脈內sodium amytal注射(瓦達試驗)決定語言及記憶功能優勢大腦半球之初步經驗

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呂炳榮[5] 徐道昌[1]

本研究總共收集了5位罹患複雜性局部癲癇發作的患者，其中4位為男孩，1位為女孩。他們的發病年齡由3至11歲不等，發病頻率由一個月數次到一天數十次不等。其中4位患者慣用右手，1位慣用左手。他們的智力均落在正常範圍內。3位患者的磁振攝影檢查有病灶發現。24小時錄影及腦波檢查顯示有4位患者癲癇病灶位於右側顳葉，1位位於左側顳葉。瓦達試驗結果顯示有4位患者的語言優勢大腦位於左側大腦半球，1位位於右側大腦半球。在記憶功能方面，除1位患者不管語言或非語言記憶的優勢大腦均位於左側大腦半球外，其餘患者兩側大腦半球對語言及非語言記憶均有不等程度的管轄能力。因經過兩年以上的抗癲癇藥物治療均無法有效控制癲癇的發作，有4位患者(3位為左優勢大腦，1位為右優勢大腦)接受了癲癇病灶該側的局部顳葉切除術，均為非語言優勢大腦半球的顳葉。手術後患者均未發生失語症與失憶症，可說是間接證明了瓦達試驗的準確性。此4位患者術後癲癇發作的頻率及嚴重程度均有顯著的降低。

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