



Case Report

A case report of a Wada test after dominant hemisphere multiple hippocampal transections: Pathophysiology of confusion after amobarbital injection



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ABSTRACT

Dialepsis is defined as a predominant alteration of consciousness with preservation of motor tone and the ability to perform movements. While dialepsis is a common feature of both focal and generalized epilepsies, its precise symptomatogenic zone and pathogenesis remain undefined. This case report describes a patient who underwent intracarotid amobarbital procedures before and after dominant hemisphere multiple hippocampal transections. From our observations, we propose a possible pathogenesis for the generation of dialeptic seizures.

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1. Introduction

The dominant temporal lobe houses two important functions for human behavior: language and memory. Patients with left temporal epilepsy, nonatrophic hippocampi, and normal verbal memory have been shown frequently to experience a postoperative worsening of their verbal memories compared with patients with atrophic hippocampi and impaired verbal memories [1].

Because of possible deleterious consequences associated with surgery on this region, localization of language and memory is of paramount importance before temporal resection or multiple hippocampal transections (MHTs) are performed. The intracarotid amobarbital procedure (IAP, Wada test) was developed in 1949 by Juhn Wada to determine language lateralization and was later expanded to assess verbal memory lateralization [2]. It has previously been observed that amobarbital injections into the dominant hemisphere tend to produce a more significant alteration of consciousness (confusion) compared with injections into the nondominant hemisphere [3–5], although one study asserted the side of injection does not influence the level of consciousness [6]. It was further observed that if the dominant hemisphere was injected second, arousal could be additionally decreased as compared with injection of the dominant lobe first. This was thought to be due to a residual sedative effect within the

contralateral hemisphere, thus eliciting some simultaneous functional disruption of both hemispheres [6].

In conclusion, there seems to be disagreement within the literature if loss of awareness (confusion) that can occur during IAP is due to selective inactivation of the dominant hippocampus or is due to bilateral inactivation of both hippocampi. In that context, we report a patient who had MHT of the left temporal lobe without alteration of consciousness or memory during presurgical IAP but had marked impairment of consciousness, perseverations, and no memory of events during amobarbital injection of the intact right hemisphere during post-MHT IAP. This observation strongly suggests that IAP-induced confusion is due to bilateral hippocampal inactivation.

2. Case study

A 45-year-old ambidextrous male presented with paroxysmal episodes. The episodes began abruptly with 10–20 s of déjà vu followed by an occipital, throbbing headache that sometimes spread throughout the head. Consciousness was lost if the pain was severe. His wife then described generalized body shaking lasting approximately 1 min followed by 1 min of complete unresponsiveness. Upon awakening, he was confused and had slurred speech. It took 30–60 min to return to his baseline. He has taken both topiramate and lamotrigine in the past. Topiramate was stopped because of cognitive side effects and lack of seizure control. At presentation, he was taking lamotrigine 600 mg daily but continued to have two episodes monthly.

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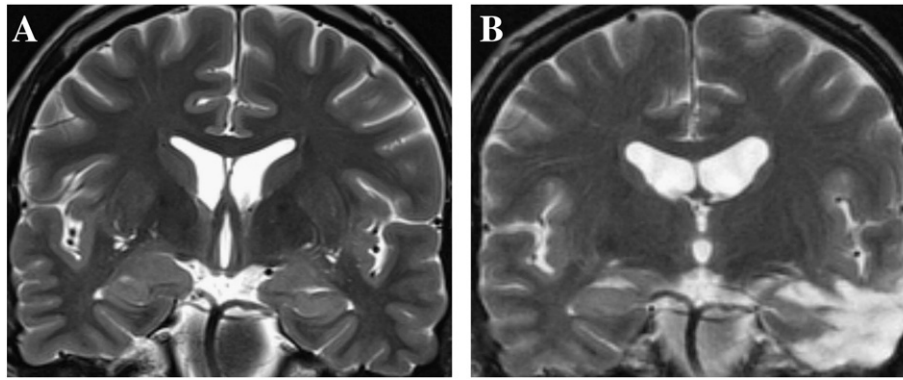


Fig. 1. Subpanel A is a representative preoperative coronal T2 section. Subpanel B is a representative postoperative coronal T2 section. Note should be made of the absence of the left temporal pole and hippocampal atrophy after patient's multiple hippocampal resections with accompanying temporal resection.

He was admitted to our epilepsy monitoring unit for further work-up. He had one seizure that began with déjà vu, followed by slurred speech and difficulty following commands, and concluded with secondary generalization. Analysis of the EEG seizure pattern showed a rhythmic delta activity that began in the temporal leads (F7, T7, and P7). An MRI done during that admission suggested but was not definitive for left mesial temporal sclerosis (Fig. 1). He was diagnosed with left mesial temporal lobe epilepsy and was felt to be a good surgical candidate.

He underwent a preoperative IAP to characterize language and memory localizations. One hundred twenty-five milligrams of sodium amobarbital was injected in each carotid artery, the left carotid artery being injected first. Angiograms done to ensure proper placement of the catheter revealed no contralateral blood flow during dye injection. Approximately 30 min elapsed between amobarbital injections. Language was assessed by testing fluency and naming during the anesthetized state. Memory was assessed by testing spontaneous recall and cued object recognition of the words and pictures shown during and after the anesthetized state. It took 181 s for him to regain language capabilities after left carotid artery injection, but he maintained language capabilities throughout injection of the right carotid artery. He recognized 8/12 pictures and words shown after the amobarbital injection of both the right and left carotid arteries (Table 1). Therefore, he was determined to have left language lateralization and bilateral memory representation. Importantly, he maintained attention and had no perseverations or roving eye movements during the pre-MHT IAP.

The patient proceeded to invasive monitoring with depth electrodes. Invasive monitoring demonstrated an epileptogenic zone in the left hippocampus. In an attempt to minimize postsurgical memory deficits, left MHT along with a left anterior temporal lobectomy including amygdala resection was performed. Postoperative pathology did not demonstrate hippocampal sclerosis.

After surgery, the patient initially did well but, unfortunately, relapsed and continued to have seizures, although at a decreased frequency as compared his presurgical state. Additional surgery was considered in order to provide higher probability of seizure freedom. Postoperative EEG demonstrated only focal left temporal slowing. Repeat MRI showed an absence of the left temporal pole and amygdala with significant atrophy of the transected left hippocampus (Fig. 1).

A repeat IAP was done using the same protocol as used in the first procedure, including initial injection of the left carotid artery, except

that a different set of pictures and words were used to minimize practice effect. Approximately 30 min again elapsed between amobarbital injections. It took 200 s for him to regain language capabilities after left carotid artery injection. He maintained language capabilities throughout injection of the right carotid artery. He recognized 5/12 and 8/12 pictures and words shown after amobarbital injection of the right carotid artery and the left carotid artery, respectively (Table 1). After right carotid injection, however, he became extremely drowsy and required continuous stimulation to maintain his attention to the IAP protocol words and pictures shown to him. His eyelids were physically held open, as he continuously tried to close them. His eyes moved in a roving fashion after right carotid injection. His verbal language capabilities were demonstrated as part of a striking perseveration, manifesting as continued counting in addition to the maintenance of his right arm up despite continued instruction to stop counting and lower his arm. The patient fully recovered in approximately 20 min after the injection and reported no memory of the speaking or motor perseveration.

Lastly, the patient described both word finding and memory difficulties postoperatively. Pre-MHT neuropsychology testing revealed that auditory memory scores were in the 42nd–50th percentile range, but post-MHT neuropsychology testing showed that auditory memory scores had now dropped to the 6th–23rd percentile range (Table 2).

3. Discussion

This case report supports the hypothesis that alteration of awareness after amobarbital injection is the consequence of bilateral hippocampal dysfunction. Prior to surgical intervention, there was no decreased awareness after injection of either hemisphere. After surgical intervention that resulted in disrupted left hippocampal function, amobarbital injection into the dominant left hemisphere predictably produced no confusion. However, a striking loss of awareness with motor and language perseverations was observed after amobarbital injection of the nondominant right hemisphere. We hypothesize that the decrease in consciousness was caused by acute bilateral inactivation of both hippocampi: the intact, nondominant hippocampus temporarily anesthetized by amobarbital and the dominant hippocampus permanently lesioned with MHT. As he experienced no alteration in consciousness during pre-MHT IAP, we conclude that his epileptic, although nontransected,

Table 1
IAP results.

	Language lateralization	Left carotid artery spontaneous recall	Left carotid artery recognition	Right carotid artery spontaneous recall	Right carotid artery recognition
Pre-MHT IAP	Left	1/12	8/12	0/12	8/12
Post-MHT IAP	Left	1/12	8/12	0/12	5/12

Table 2
Auditory memory test results.

	Auditory immediate memory (%)	Auditory delay memory (%)	Auditory recognition delay (%)
Pre-MHT	42%	47%	15%
Post-MHT	6%	23%	16%

hippocampus was able to independently support maintenance of attention. After MHT, the iatrogenically dysfunctional left hippocampus was unable to support maintenance of attention independently, and the previously described confusion and perseveration occurred.

During his acute confusion, our patient had no loss of muscle tone and retained the capacity for voluntary movement ipsilateral to the amobarbital injection. This state has similarity to dialeptis. Dialeptis is defined as a state where the predominant change is an alteration of consciousness with no or very limited motor manifestations [7]. There has not been a description for the dialeptis symptomatogenic zone in the literature. We hypothesize here that rather than one discrete area being responsible for dialeptis, dysfunction of multiple discrete areas (i.e., both hippocampi) is required to produce this clinical state. Our patient had significant difficulty in maintaining attention during amobarbital injection of his healthy right hippocampus. Even more tellingly, he had no memory of the considerable verbal perseveration or attention difficulties. The loss of short-term memory in our patient is reminiscent of patient H.M. and his well-known anterograde amnesia following bilateral temporal lobe resection [8].

Multiple hippocampal transection has been reported as a procedure that possibly spares verbal memory [9]. However, the significant drop in memory seen after MHT, concordant with left hippocampus atrophy on post-MHT MRI, suggests that MHT produced significant hippocampal damage, at least in this case. Therefore, the transected hippocampus appears unable to maintain awareness or a normal level of consciousness independently after the right carotid amobarbital injection. Indeed, Rosadini and Rossi made a similar observation on a subset of patients

on whom they performed the IAP. In their study subset, 12 patients in whom there was either contralateral brain damage or large collateral arterial circulation supplying both hemispheres had decreased level of consciousness during IAP [10].

4. Conclusions

In summary, this case shows that acute bilateral hippocampus inactivation can produce dialeptis with relative unresponsiveness to external stimuli, perseverations, and amnesia for the events. This finding suggests that the symptomatogenic zone responsible for dialeptis is the bilateral inactivation of the hippocampi.

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