Cerebral amobarbital sodium distribution during Wada testing: utility of digital subtraction angiography and single-photon emission tomography

Abstract We aimed to determine if the cerebral distribution of anesthetic during Wada testing is reflected by findings on digital subtraction angiography (DSA) and single-photon emission computed tomography (SPECT) and if the findings on these studies are relevant to the outcome of the Wada test. We carried out selective internal carotid artery (ICA) DSA on 29 patients who underwent studies prior to a Wada test. In patients without angiographic cross-filling, amobarbital and a radiotracer were injected into each ICA, beginning with the epileptogenic side. In patients with cross-filling, the ICA ipsilateral to the epileptogenic focus was injected with amobarbital and radiotracer while the other was injected with amobarbital alone. We analyzed the DSA studies for cross-filling and filling of the posterior cerebral arteries (PCA). We reviewed the SPECT for activity in the territories of the anterior, middle cerebral, and posterior cerebral arteries. We compared the results of both studies with the success or failure of the neuropsychological portion of the Wada test. In 20 patients without cross-filling, the results of DSA and SPECT were comparable: symmetrical hemisphere activity was seen. In nine patients with cross-filling, SPECT showed bilateral, almost symmetrical activity. Filling or non-filling of the PCA correlated with activity (or lack of it) in the medial temporal and occipital regions in all patients. The Wada test was considered successful in all patients. The findings on SPECT did not alter interpretation of the Wada test and we suggest that it may not be needed in all patients undergoing Wada testing.

Key words Wada test · Epilepsy · Angiography · Single-photon emission tomography

Introduction

The Wada test is usually performed in patients with chronic, intractable epilepsy who are candidates for temporal lobectomy. It consists of an injection of a short-acting anesthetic, generally amobarbital sodium, into one or both internal carotid arteries (ICA) followed by neuropsychological tests which aim to lateralize speech and predict postoperative memory function. A catheter angiogram is generally performed before the test to map the presumed distribution of amobarbital [1]. Alternately, the anesthetic may be combined with Tc-99m hexamethyl-propyleneamine oxi (HMPAO), a blood flow agent with a first-pass extraction rate of 70% [1,2]. It is believed that the distribution of activity on single photon emission computed tomography (SPECT) reflects the distribution of the anesthetic and aids interpretation of the neuropsychological portion of the Wada test. Although studies have addressed the utility of SPECT as part of the Wada test, differences in technique have yielded differing results. Nevertheless, some institutions, such as ours, use SPECT in all Wada tests.
Our purpose was to determine if findings on digital subtraction angiography (DSA) reflect the distribution of activity on Tc-99m HMPAO SPECT and if these findings are relevant to the results of the test.

Materials and methods

We reviewed the selective cerebral (DSA) and SPECT of 29 patients who underwent Wada testing with injection of amobarbital sodium and Tc-99m HMPAO into each internal carotid artery (ICA). All were candidates for epilepsy surgery and they (or their guardians) gave written consent before the test. The procedure consisted of bilateral ICA DSA using 5 French catheters positioned at C1–2. All patients received a manual injection (6–8 cc) of nonionic 60 % iodinated contrast medium, with frontal and lateral DSA filming at 2s. The posterior circulation was not studied by vertebral artery injection in any patient. We reviewed the DSA for evidence of cerebral hemisphere cross-filling via patent anterior communicating arteries and for filling of the posterior cerebral artery (PCA) on both ICA injections.

Immediately after the diagnostic angiogram, the ICA on the side of the presumed epileptogenic focus was again catheterized with the tip of the catheter at C1–2. A 5 cc syringe was filled with 150 mg amobarbital in 1 cc saline, and 1 mCi (1 cc) of Tc-99m HMPAO prepared no more than 30 min before injection was then mixed with the anesthetic. A 5 cc syringe containing heparinized saline was also prepared and both were attached to the catheter using a three-way stopcock. The anesthetic/radiotracer mixture was then hand injected over 5 s. Immediately after the injection, the port for saline was opened and 2–3 cc was injected to flush residual anesthetic/radiotracer (1.2 cc dead-space) in the catheter. The success of the injection was confirmed by weakness of the opposite limbs and predominantly ipsilateral slowing of the EEG.

The catheter was then pulled back into the descending aorta and the neuropsychological testing was performed. After this, we waited 30 min and then repeated the Wada test on the other side. If cross-filling was present in the initial DSA, only amobarbital was injected in the second ICA. If no cross-filling was present amobarbital and Tc-99m HMPAO were given in both ICA. The catheter was then removed.

All patients underwent SPECT within 2 h of the Wada test, on a high-resolution camera with low-energy collimators. We acquired 64 frames obtained every 10 s with a 360° rotation and a 64 × 64 matrix. Data were processed using filtered back-projection and viewed in coronal, axial, and sagittal projections. SPECT was interpreted as showing unilateral or bilateral activity in the regions of anterior (ACA), middle (MCA), and posterior cerebral arteries. Symmetry of cerebral hemisphere cerebral uptake was judged by eye. The findings were then correlated with those of the DSA.

Results

We carried out 29 Wada tests in which the received the combination of anesthetic and radiotracer. The patients varied in age from 16 to 55 years; seven were male. No primitive communication between an ICA and the vertebrobasilar circulation was found. SPECT showed no posterior cranial fossa activity in any patient.

Patients without cross-filling on DSA

There were 20 patients (69 %) who showed no filling of the contralateral cerebral circulation on DSA. Of these, 10 (34.5 %) had a left epileptogenic focus and the anesthetic/radiotracer was initially injected into the left ICA; the PCA was filled in eight of these. SPECT showed left-sided activity in all 10, with no activity in the territory of the PCA in two (Fig. 1).

In ten patients (34.5 %) with a right focus, the right ICA was initially injected and showed no cross-filling. The PCA did not fill with any of these injections. SPECT showed activity in the right cerebral hemisphere in all cases without activity in the PCA territory.

In all 20 patients, the contralateral ICA was also injected with the amobarbital/radiotracer mixture. SPECT showed activity in the same vascular territories as the DSA in all cases.

Patients with cross-filling on DSA

Cross-filling via a patent anterior communicating artery was seen in nine DSA studies. Six patients (20 %) with a left-sided focus showed cerebral cross-filling when the left ICA was injected, in two of whom, the ipsilateral PCA was not filled. Bilateral, almost symmetrical activity was seen on SPECT in all six, with no activity in the territory of the PCA in two. In seven patients, SPECT showed almost symmetrical bilateral cerebral activity, including the territory of the PCA (Fig. 2).

In three patients with a right-sided focus, the right ICA was initially injected, showing filling of the left cerebral hemisphere via a patent anterior communicating artery. The PCA did not fill in any of these cases. SPECT showed bilateral, almost symmetrical activity in all three patients but none in the PCA territory (Fig. 3).

Discussion

The distribution of amobarbital sodium after injection into an ICA is thought to influence the results of a Wada test. Anesthesia of only one cerebral hemisphere is desired, to document lateralization of speech dominance [3,4]. Anesthesia in the territory supplied by the PCA is desired for memory testing. Angiography is commonly used to document anatomic variations which may affect the distribution of the anesthetic [1]. However, it may not accurately reflect cerebral blood flow, due to differences in injection volume and pressure, greater viscosity of the contrast medium, position of catheter, and variations in the cardiac cycle [1]. Conventional angiography requires a larger volume of contrast medium than DSA, and in a number of centers a pressure injector is commonly used to deliver it; this may not then reflect the