



● *Original Contribution*

EVALUATION OF THE TEMPORAL ACOUSTIC WINDOW FOR TRANSCRANIAL DOPPLER IN A MULTI-ETHNIC POPULATION IN BRAZIL

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Abstract—The aim of this study was to relate the presence of a temporal acoustic window (TAW) to the variables sex, age and race. This observational study was conducted in patients under etiologic investigation after stroke, sickle-cell anemia and hospitalization in an intensive therapy neurologic unit. TAW presence was confirmed by bilateral assessment by two neurologists *via* transcranial Doppler (TCD). Multiple logistic regression was performed to explain the presence of the window as a function of sex, age and race. In 20% of the 262 patients evaluated, a TAW was not present. The incidence of TAW presence was greater in men (odds ratio [OR] = 5.4, 95% confidence interval [CI] = 2.5–11.7, $p < 0.01$); lower with increased age (OR = 0.9, 95% CI = 0.92–0.97, $p < 0.01$); and lower among those of African and Asian descent (OR = 0.32, 95% CI = 0.14–0.70, $p = 0.005$). On the basis of the results, more men than women had TAWs, and the decrease in TAWs was associated with increased age and African or Asian descent. (E-mail: gluvizutto@fmb.unesp.br) © 2015 World Federation for Ultrasound in Medicine & Biology.

Key Words: Transcranial Doppler, Temporal acoustic window, Demographic data, Cerebrovascular diseases.

INTRODUCTION

Transcranial Doppler (TCD), a non-invasive method for evaluating cerebral blood flow velocity, is widely used in health care, with extensive applications in neurovascular clinical practice (Babikian and Lawrence, 1993; Naqvi et al. 2013). Its principal clinical applications are: investigation of the right–left shunt, for example, in patent foramen ovale; monitoring of patients with sickle-cell anemia; evaluation of cerebral vasomotor reactivity during the acute phase of stroke with evaluation of arterial occlusions and sonothrombolysis; evaluation of cerebral vasospasm secondary to subarachnoid hemorrhage; assessment of cerebral circulatory cessation in brain death; evaluation of intracranial stenosis; and detection and quantification of spontaneous micro-embolic

signals in cerebral circulation (Gao et al. 2004; Rorick et al. 1994; Sloan et al. 2004). Acquisition of a temporal acoustic window (TAW) transcranial Doppler image may be limited in a varying percentage of patients by sex, race and age, given that this physical characteristic is related to the thickness and density of the temporal bone (Wijnhoud et al. 2008).

The aim of this study was to determine if there is a relationship between TAW presence and sex, age and race in a Brazilian multi-ethnic population. The central hypothesis of the study is that TAW presence is decreased in women, individuals of African and Asian descent and the elderly.

METHODS

Study population

This analytical observational study was carried out at two centers (Botucatu School of Medicine and USP School of Medicine at Ribeirão Preto) with patients under etiologic investigation after diagnoses of stroke and sickle-cell anemia and hospitalization in an intensive therapy neurologic unit and stroke unit between March 2011 and July 2013. All patients received a defined

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diagnostic hypothesis from and were monitored by the medical team. The independent variables in the study were sex, age (in years) and race (whites and individuals of African or Asian descent). Presence of a TAW was the outcome; its unilateral or bilateral presence was confirmed by two neurologists certified in neurosonology; TAWs were considered absent not detected unilaterally or bilaterally by a neurologist, with confirmation by a second neurologist.

This research was approved by the Research Ethics Committee of the Ribeirão Preto School of Medicine (Protocol No. 4900/2011), and informed consented was obtained from all patients or their relatives.

TCD examination

Presence of a TAW was confirmed with a portable TCD device (DWL, Doppler Box model, Compumedics, Singen, Baden-Württemberg, Germany) placed between the lateral margin of the orbit and the ear above the zygomatic arch. Low-power pulsed-wave 2-MHz transducers 1.7 cm in diameter were used with TCD-8 software (Version 8.00 K) with a pulse repetition frequency of 6,500 Hz and programmable high-pass filter of 50 to 600 Hz.

Statistical analysis

Agreement between the two neurologists on the presence of a TAW was evaluated with the κ coefficient. The relationship model being tested presupposes that sex, age and race are correlated with presence of a TAW. On the basis of simple random sampling, type I and II errors equal to 0.05 and 0.20, respectively, and the consideration that about 88% of patients were between 65 and 67 y (median age of sample), a minimum sample size of 262 individuals is necessary to permit detection with an odds ratio <0.45 . Multiple regression was performed to explain TAW presence as a function of sex, age and race. Relationships between independent variables and outcomes were considered statistically significant at $p < 0.05$. Statistical analysis was carried out with SPSS software (Version 15.0, SPSS, Chicago, IL, USA).

RESULTS

The 262 patients evaluated included 128 females and 134 males, of median age 66 y; 77% were white and 23% were of either African or Asian descent. Twenty percent of the total sample did not have a TAW, and in all of these cases, the absence of a TAW was bilateral; no unilateral absence of TAW was observed in this casuistic (Table 1). Inter-observer variability between the two neurologists who assessed patients for TAW presence had a high correlation ($\kappa = 0.95$, $p < 0.01$, with agreement = 98%).

Table 1. Description of sample

Sex	
Female	128 (49%)
Male	134 (51%)
Age (y)*	66 (1–96)
Race	
White	202 (77%)
Black/Asian	60 (23%)
Temporal acoustic window	
Absent	53 (20%)
Present	209 (80%)

* Median (range).

The incidence of TAW presence (Table 2) was greater among men (OR = 5.4, 95% CI = 2.5–11.7, $p < 0.01$), lower with increased age (OR = 0.9, 95% CI = 0.92–0.97, $p < 0.01$) and lower among those of African and Asian descent (OR = 0.32, 95% CI = 0.14–0.70, $p = 0.005$).

Figure 1 illustrates the percentage presence of TAWs relative to the independent variables of the study. Among the patients with TAWs (209 patients or 80% of the sample), 91% were male and 67% female. The percentage presence of TAWs diminished with increasing age. A TAW was present in 70% of those of African or Asian descent (60 patients or 23% of sample) versus 82% of whites (202 patients or 77% of sample).

DISCUSSION

Twenty percent of the patients in this study did not have a TAW as assessed with TCD using the 2-MHz probe. In the medical literature, this percentage varies from 3% to 34% among the populations studied, which range from healthy volunteers to patients with cerebrovascular disease (Barbosa et al. 2006; Klotzsch et al. 1998; Kwon et al. 2006; Marinoni et al. 1997). A study in stroke patients revealed that depending on race, age or sex, up to 35% of patients do not manifest a TAW on examination (Kaps et al. 1990). Many studies have reported that absence of the window is associated with advanced age, female sex or African descent and with temporal bone thickness (Itoh et al. 1993; Kwon et al. 2006).

Acquisition of a TAW transcranial Doppler image occurred more frequently among male than female patients (Klotzsch et al. 1998; Kwon et al. 2006; Marinoni et al. 1997; Wijnhoud et al. 2008). The temporal bone is thicker in women than in men, as reported in diverse studies (Jarquin-Valdivia et al. 2004; Kwon et al. 2006). Such studies have indicated that cranial thickness is related to the presence or absence of a TAW, with the sound waves being spread by the spongy bone diploe (Fry and Barger 1978). Hyperostosis is the greatest

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