

Ocular compression pressure during EEG for the study of increased vagal reactivity

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ABSTRACT – Ocular compression (OC) is a maneuver performed during EEG to demonstrate increased vagal reactivity in children with suspected syncope including breath-holding spells. We examined the relationship between the simulated OC pressure exerted by different physicians and the cardiac slowing responses that they had historically obtained as per EEG records. Simulated OC was performed by each physician using a sphygmomanometer. EEGs were reviewed for the rate of positive cardiac slowing per physician. Among three physicians who performed a total of 73 OC, the mean \pm SD of applied pressure were 29.0 ± 2.4 , 60.7 ± 3.5 and 42.4 ± 2.5 mmHg, respectively. There was good intra-physician consistency for the OC pressures exerted. The mean pressure exerted was significantly different between physicians ($p < 0.001$, ANOVA). The positive response rate for cardiac slowing among these physicians was 11/37 (29.7%), 10/21 (47.6%) and 8/15 (53.3%) respectively. The difference in positive OC responses between physicians was not significant ($p = 0.127$, chi-square). Higher OC pressures did not translate into more positive responses. A pressure of 30 mmHg is as good as 60 mmHg in demonstrating cardiac slowing during OC.

Key words: ocular compression, breath-holding spell, syncope, pediatric EEG

Ocular compression (OC) is a technique used to evaluate the vagal response induced by digital ocular pressure sustained for 10 seconds during an EEG (Stephenson 1980). OC has traditionally been used in our hospital to evaluate patients suspected of ha-

ving syncopal episodes, including breath-holding spells. This technique has proven value in aiding the diagnosis of syncope/breath-holding spells in children, mostly by reproduction of clinical symptoms (Brenningstall 1996, Gelisse *et al.* 2007, Lombroso and Lerman 1967). Though this technique was described almost a century ago and has been used for about 60 years in evaluating syncope in infants and children, the cardiac response to varying degrees of ocular pressure has not been previously studied.

We studied the OC pressures exerted by various physicians to determine the

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range of pressures and to compare it with their historical percentage of positive results.

Methods

Institutional Review Board approval was obtained from the Drexel University College of Medicine for this study. We devised a technique to compare the pressure exerted by various physicians who routinely perform OC in our section. A manual sphygmomanometer was initially inflated and made tense to the pressure of 20 mmHg, which approximates the normal intra-ocular pressure of 10-20 mmHg. The physicians were blinded to the manometer pressure-display dial and were asked to exert sustained pressure on the cuff using their thumb as if it were the patient's eye. The resultant pressure measured on the manometer was recorded. Each physician was asked to perform the test 10 times, with an interval of 10 seconds between each attempt. The manometer was re-calibrated to 20 mmHg between attempts if there was a change noted in the pressure. The procedure was repeated after one month to check for temporal consistency in pressures exerted.

EEG records with simultaneous OC were analyzed from November 2004 to November 2007. The physician performing OC, as well as the rate of positive cardiac slowing responses to OC (defined as asystole > 2 seconds), was also reviewed.

Analysis

The data were analyzed using SPSS version 15.0. The mean pressures between physicians were compared using one-way ANOVA. The general linear model with repeated measure was used to assess consistency of mean pressures exerted (mmHg) between baseline and at one month. The positive response rate to OC was compared among various physicians using the chi-square test.

Results

Pressures exerted by OC simulation

Three physicians participated in the study. The combined mean pressure exerted was (mean ± SD) 44 ± 13.5 mmHg

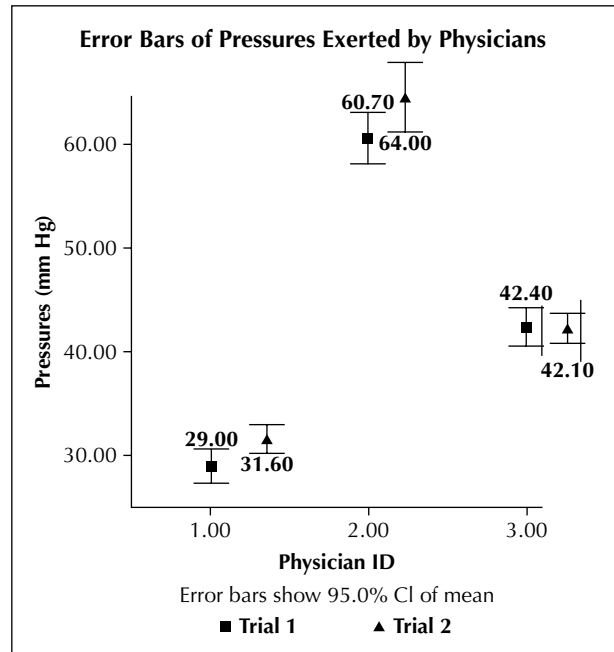


Figure 1. Mean pressure exerted (mmHg) by the different physicians at trial 1 and 2, with error bars.

with a range of 24-65 mmHg at baseline (trial 1) and 45.9 ± 14.1 mmHg with a range of 30-70 mmHg one month later (trial 2). There was a significant difference in the simulated ocular compression pressure exerted among the different physicians, with mean ± SD pressures (mmHg) of 29.0 ± 2.4, 60.7 ± 3.5 and 42.4 ± 2.5 respectively (p < 0.001, ANOVA, table 1). The general linear model with repeated measures showed no statistical difference between pressures performed at baseline and at one month for all three physicians.

OC results among various physicians

OC was performed in 233 recordings (EEGs) out of 5 894 reviewed during the period of the study (4%). Of these, the physician performing OC was noted in 102 records. Adequate numbers for statistical analysis were obtained for the three physicians (physician ID 1, 2 and 3 in table 1 and figure 1) who performed a total of 73 OC (37, 21 and

Table 1. Pressures exerted by different physicians during simulated OC (in mmHg).

Physician ID	Trial 1 Pressures: mean ± SD (mmHg)	Trial 2 Pressures: mean ± SD (mmHg)	Ocular compression result : positive/total (% positive)
1	29 ± 2.4	31.6 ± 2.1	11/37 (29.7%)
2	60.7 ± 3.5	64 ± 5.2	10/21 (47.6%)
3	42.4 ± 2.5	42.1 ± 2.2	8/15 (53.3%)
Mean	44 ± 13.5	45.9 ± 14.1	29/73 (39.7%)
Comparison of means (test used)	p < 0.001; F = 312.9 (ANOVA)	p < 0.001; F = 229.6 (ANOVA)	p = 0.127 (chi-square)

15 respectively). The number of positive and negative OC responses for them is presented in *table 1*. There was no statistical difference in the rate of positive response between physicians (chi-square, $p = 0.127$).

Discussion

At our institution, patients are often referred for EEG before consultation with a neurologist. OC is performed to elicit the oculo-cardiac reflex during the EEG when there is a diagnostic uncertainty regarding the etiology of episodes of loss of consciousness. The procedure is done by one of the physicians from the neurology section after explaining the procedure to the patient and the parents. Sustained OC for 10 seconds (Lombroso and Lerman 1967, Stephenson 1980) is applied using the thumbs placed over the eyes, with sufficient pressure to achieve a 2-3 mm blanching of the nails (Stephenson 1980). OC is not performed in patients wearing contact lenses.

OC was initially described in 1908 by Aschner and Dagnini independently (for original references see Stephenson 1978). The afferent arc of the oculo-cardiac reflex lies in the sensory branches of the trigeminal nerve (V1) and the efferent arc is the vagus nerve as shown by Wagner (1942). An abnormally increased vagal reactivity is reflected in bradycardia and possible asystole. Lombroso and Lerman (1967) have previously taken an asystole longer than two seconds to be the cut-off for a positive cardiac response to ocular compression, which provides ancillary support for increased vagal reactivity. Our previous research suggested that an increase in the RR interval of 0.5 seconds compared to baseline increased the sensitivity from 26 to 46% (Khurana *et al.* 2006). Other authors advocate that the "episodes of loss of consciousness in the young should be diagnosed by clinical history" (Stephenson 2007). Other methods of assessing the vagal reactivity include the tilt-table test, diving response (apneic facial immersion), Valsalva maneuver and carotid sinus massage (Arnold *et al.* 1994, Jaeger *et al.* 1990).

The ocular compression technique is easy to perform and has never proven to cause complications in this context. There have been cases where OC has disproved long and erroneous diagnoses of epilepsy, thereby avoiding unnecessary and potentially harmful treatment with anti-epileptic drugs. Gelisse *et al.* (2007) reported a case where a patient who had long been on anti-epileptic treatment was confirmed to have a syncope after the demonstration of a typical episode during ocular compression. The perceived dangers of the OC maneuver, other than the asystole induced, stem from anecdotal reports of central retinal and posterior ciliary artery occlusion, cataract, retinal detachment, ocular deformation (Hoff *et al.* 1992) and even ocular rupture (Mathis *et al.* 1982). However, the aforementioned complications have not been reported in

the context of OC performed during EEG. These have been reported in association with ocular surgery or repeated ocular compression for averting cardiac tachyarrhythmias. We have not encountered these complications in more than 18 years of OC in our practice as has been the experience of previous authors (Stephenson 1980).

Our results indicate a good consistency during repeated measurements by the same physician (*table 1*, *figure 1*). There was a significant difference in the simulated ocular compression pressure exerted by different physicians with pressures ranging from 24 to 65 mmHg during simulated testing (first trial). However, the rate of cardiac slowing responses to OC among different physicians was not significantly different. Furthermore, the physician with the highest rate of responses (53%) exerted a mean \pm SD pressure of 42.4 ± 2.5 mmHg, which was not the highest pressure. Thus, higher pressures during OC do not necessarily translate into higher rates of cardiac reactivity. The main concern for using OC among the medical community has been the potential risk of complications linked to the high pressures exerted. We provide evidence that a lower pressure is as likely to achieve the required effect (vago-cardiac response) and should reduce the likelihood of rare but feared complications.

It is also known that normal ocular pressure increases with age, reaching adult values at around 12 years (Sihota *et al.* 2006). It is possible that patients in different age groups may require a higher or lower OC pressure to elicit a similar clinical response. An OC device could help in standardizing the pressure exerted by physicians and allow different pressures to be used at various ages, for example, when needed for breath-holding spells *versus* syncopal episodes.

Previous research has looked into the degree of cardiac inhibition required to prove a diagnosis of increased vagal reactivity. Attempts have been made to establish standards for infants (Ramet *et al.* 1988, de Broca *et al.* 1990). However, normative values do not exist as to the extent of pressure needed to be exerted to produce such a result.

We conclude that there is significant variation between physicians as regards to the pressure exerted manually during OC, but with no difference in the rate of the cardiac slowing response. A pressure of 30 mmHg is as likely as 60 mmHg to induce cardiac slowing. Prospective studies are needed to find the optimal minimum pressure that yields maximum sensitivity at different ages. \square

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