Invited Editorial Comment

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# Ocular compression a century on: time for a thumbs-off approach?

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This issue includes a study (Haneef *et al.* 2008) of simulated ocular compression (OC) by physicians who "routinely" performed OC during EEG examinations when syncopal episodes - including breath-holding spells - were suspected. The authors found that though each of those three physicians exerted a different range of pressure on a sphygmomanometer cuff when asked to use their thumbs as if the inflated cuff was the patient's eye, the thumb pressure generated bore no relation to the physicians' previous score of "positive" OC responses during EEGs.
So it might not matter how hard you press the eyeballs if you want to elicit the oculocardiac reflex (OCR) during EEG. **But should you?** A brief historical overview may assist practitioners and readers.

## Historical introduction

It is 100 years since the coeval but independent discovery of the OCR by Aschner (1908) and Dagnini (1908). Aschner (1908) also discovered the oculorespiratory reflex (ORR), surprisingly less well known. In the OCR ocular manipulation leads (*via* afferents in the ophthalmic branch of the trigeminal nerve and efferents in the cardiac vagus) to bradycardia with or without asystole (Blanc *et al.* 1983), while the ORR (*via* the same afferent pathway, but with a non-vagal efferent route) leads to bradypnoea with or without potentially hazardous apnoea (Blanc *et al.* 1988). Maulsby and Kellaway (1964) found that OC led to both bradycardia or asystole and expiratory apnoea – or at any rate prolonged expiratory activity – but they did not comment on this being related to the ORR.
Although the OCR is best known as a vagal-mediated cardio-inhibitory reflex, sympathetic withdrawal is also involved, as atropine does not abolish the OCR completely (Gandevia *et al.* 1978, Stephenson 1979).
The OCR was (and still is) (Gupta *et al.* 2007) of major importance to ophthalmic surgeons and anaesthetists. Most publications on the OCR (and indeed those few on the ORR) are from departments involved in strabismus surgery. Intra-operative recordings have shown that the OCR is a graded phenomenon as a function of tension applied to the extraocular muscles (Ohashi *et al.* 1986), likely with a polysynaptic pathway to the heart.
OC has long been used by cardiologists as one of the vagal manoeuvres for converting supraventricular tachycardia to sinus rhythm, and complications attributed to eyeball compression are confined to this group of patients (Landman and Ehrenfeld 1952, Mathis *et al.* 1982).
In the investigation of the developing autonomic nervous system in normal newborns and infants OC has proved to be a valuable tool. The OCR has been studied with respect to gestational age (Ramet *et al.* 1988), circadian rhythm (Ramet *et al.* 1992) and degree of alertness (Ramet *et al.* 1995), with attention to the situation in REM sleep (Ramet *et al.* 1988) and in quiet sleep (Ducrocq *et al.* 2006).
There are few reports of the elicitation of the OCR without co-registration of EEG. Bridge *et al.* (1943) reported two patients with a history of so-called breath-holding spells who had slowing of the heart on eyeball pressure – one had 20 seconds asystole. In a more scientific study, the OCR was examined in normal control infants, in those who had had apparently life-threatening events, and in those who were the surviving siblings of infants diagnosed with sudden infant death syndrome (Kahn *et al.* 1983). Jaeger *et al.* (1990) used OC with only an ECG strip as a prelude to head-up tilt testing.
The use of OC during EEG to elicit the OCR was enthusiastically pioneered by Henri Gastaut in Marseille (Gastaut and Fischer-Williams 1957, Gastaut and Gastaut 1958, Gastaut *et al.* 1961, Gastaut 1968). Gastaut's task was to convince the medical establishment that anoxic seizures (syncopes) were completely different from epileptic seizures.
Further references to OC and OCR may be found elsewhere (Gastaut and Fischer-Williams 1957, Stephenson 1978a, 1990, 2007): where there is doubt about the accuracy of a citation, the references following this Editorial Comment may be regarded as definitive.

## Ocular compression during EEG: what is a "positive" response?

Since Gastaut, several authors (including this commentator) have written on the use of OC during EEG and have

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proposed criteria for a "positive" OC response. Insofar as the OCR is a universal reflex, only absent in brainstem death (Born *et al.* 1985) it is no surprise that these criteria vary considerably.

Published criteria for a "positive" OC response are as follows, with the phraseology of the authors in quotations *[additional comments in square brackets]*.

– **Gastaut and Gastaut 1958**

OC "has evoked a convulsive episode identified by the family as similar to those which motivated the medical consultation".

– **Gastaut *et al.* 1961**

"Clinical symptoms of faintness with malaise, pallor, sweating and nausea followed in some cases by loss of consciousness and exceptionally by tonic convulsions". "When cardiac arrest of 3 seconds or longer occurred". "When EEG changes appeared, consisting principally of generalised high voltage slow waves indicative of ischaemic cerebral anoxia". "If, however, clear cut clinical symptoms of syncope were produced without either cardiac or EEG effects the reflex [OCR] was still considered positive".

– **Maulsby and Kellaway 1964**

"A positive response [was] defined as one which shows typical hypoxic changes in the EEG".

– **Lombroso and Lerman 1967**

"The cardiac response to ocular compression performed as described above ["pressures fixed between 100 and 200gm could be applied and held for 10 seconds"] was considered positive if an asystole of two seconds or longer was recorded. Bradycardia alone was not considered a positive result".

– **Stephenson 1978a**

"4 seconds or more asystole".

– **DiMario *et al.* 1990**

"A prompt and sustained bradycardia of 50 percent or less than resting heart rate during 10 seconds of bilateral OC". "Cardiac asystole for 2 seconds or longer and/or precipitation of a clinical attack".

– **Stephenson 1990**

"Receiver operating characteristic (ROC) constructed to discover what is an 'abnormal' duration of asystole in response to ocular compression. The cut-off of 6 seconds at the inflexion of the curve best minimizes false positives and false negatives and is thus the derived 'abnormal' value".

– **Khurana *et al.* 2006**

"A requirement of a 2-second period of asystole with ocular compression excludes many patients. Our data indicate that an RR interval increase of 0.5 seconds over baseline identifies additional patients with increased vagal tone".

## Why do ocular compression during EEG?

Previous writers have indicated both why OC is indicated during EEG and discussed the significance of the changes provoked. Again, published phraseology will be utilised, with comment in square brackets.

– **Maulsby and Kellaway 1964**

"We now employ the ocular compression test routinely in the EEG Laboratory whenever a child is referred for attacks which might be hypoxic crises. A positive response (defined as one which shows typical hypoxic changes in the EEG) tends to confirm a clinical diagnosis of transient hypoxic crises since our previous studies indicate that 40 per cent of children with known hypoxic crises show a positive response whereas less than 2 per cent of children in the normal group will show such a response".

– **Gastaut 1968**

"It is not that this procedure ["the application of nociceptive stimulation, and in particular ocular compression, during polygraphic recording"] allows the type of syncope usual in a particular patient to be reproduced, but that in children who present reflex syncopes, of whatever type, it very often shows up an exaggerated hypervagotonia, which is manifest as an immediate cardiac arrest, sometimes of sufficient length to create an experimental syncope (syncopal reflex)".

– **Stephenson 1978a**

"Ocular compression under EEG and ECG control supports the diagnosis [of reflex anoxic seizures] if asystole and/or an anoxic seizure is induced; the procedure-...should be routine in seizure or syncope evaluation, when a meticulous history still leaves room for doubt".

– **Stephenson 1978b**

"A most important reason [for 10 seconds of OC] is that the induction of a visible anoxic seizure has a most dramatic therapeutic effect on the family member (usually the mother) who is there to witness it. 'I wish this test was done on all "epileptic" children', said one relieved mother recently. 'I have been nursing patients in mental hospitals for years and would not have known this was not a grand mal unless I had seen it happen with my own eyes'". "Apart from the joy of positively knowing that the child does not have epilepsy, another therapeutic feature is the demonstration to the mother that the child's heart has already restarted by the time that the seizure is at its worst. Not only parents, but referring doctors need to be convinced, and the more asystole the greater the impact".

– **Stephenson 1980**

"In reflex anoxic seizures the response to ocular compression is greatly exaggerated, and in the majority of cases the asystole is sufficiently long (more then seven seconds) to reproduce an anoxic seizure".

– **Stephenson 1990**

"In the first place the operator should be satisfied that the procedure [OC] is justified. Justification would normally be either the reproduction of an unusual episode for diagnostic purposes, or the reproduction of a standard asystolic anoxic seizure in the presence of a parent as an aid to management".

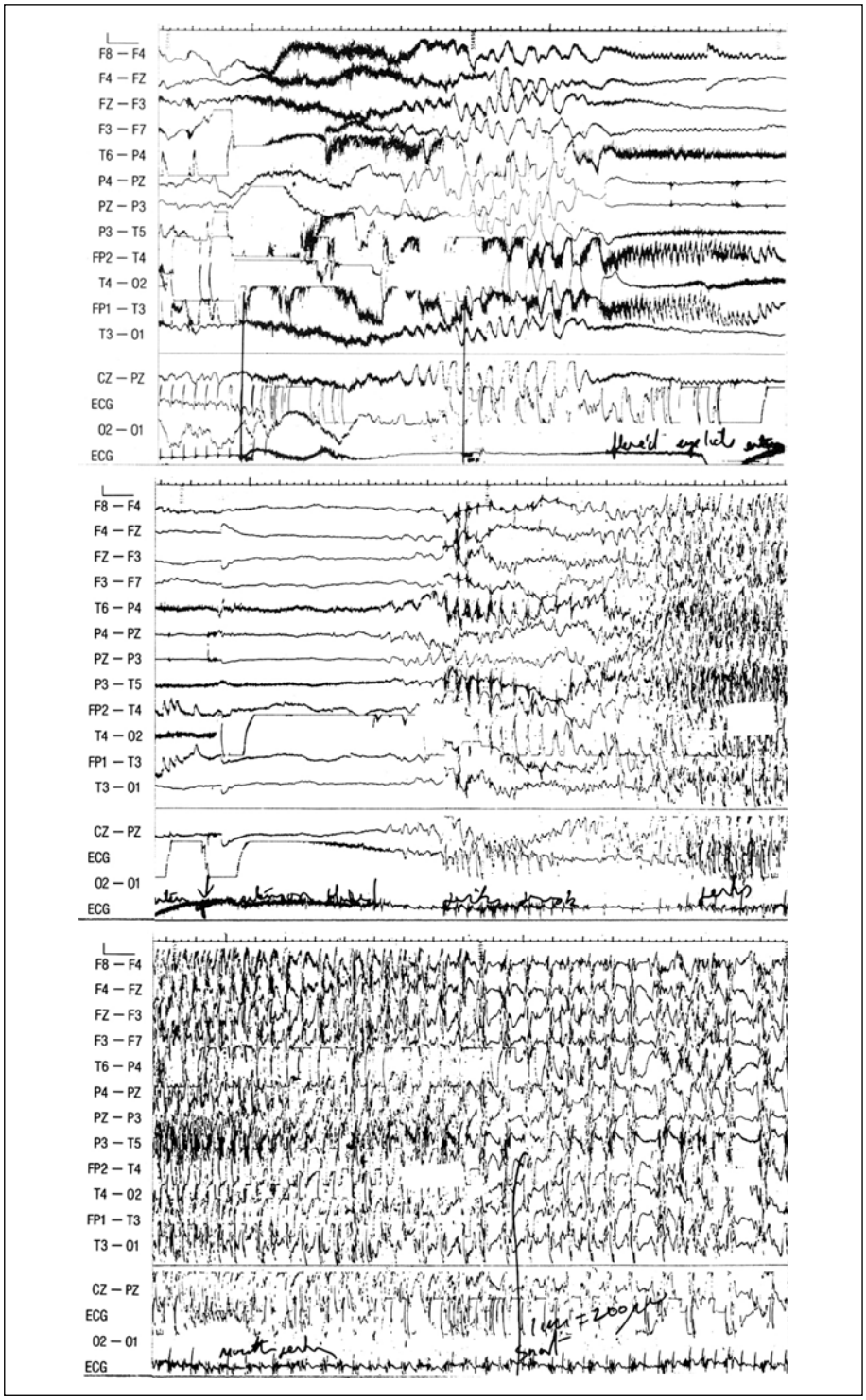


**Figure 1.** Three consecutive panels of EEG/ECG recording to show AES induced by OC. Each strip lasts 20 s. In the upper panel OC takes place between the two vertical lines. Asystole begins after only two QRS complexes on the bottom ECG channel. After 12 s the EEG is isoelectric (with rhythmic artefacts from down-beat nystagmus in channels FP2-T4 and FP1-T3). Tonic EMG on the ECG channel reflects the anoxic seizure. Midway across the centre panel and while the EEG is still isoelectric rhythmic 2-3/s. jerk artefacts are seen on the EEG and ECG channels. By the start of the lower panel rhythmic EEG spike and wave is visible, confirming the epileptic component of the AES. Clonic jerking only lasted 28 s but the child was unresponsive for a further 8 minutes (modified from Stephenson [1990], and reproduced with permission of Mac Keith Press).

– **Stephenson and McLeod 2000**
"Before the advent of event monitoring..., ocular compression by reproducing RAS [reflex anoxic seizures/reflex asystolic syncope] precisely was commonly used as a diagnostic test. Diagnostic ocular compression is now confined to three situations: *(i)* when the parents are extremely keen for the doctor to see one of the RAS; *(ii)* when the history of the suspected RAS is distinctly unusual; and *(iii)* when a history suggesting anoxic-epileptic seizures... is difficult to confirm".
– **Khurana *et al.* 2006**
"EEG with ocular compression has historically been performed in our hospital neurophysiology laboratory whenever the history was consistent with either breath-holding spells or a syncopal event. The purpose of this study was to assess the utility of this test in distinguishing children with breath-holding spells and syncope from those with epileptic events".
– **Gelisse *et al.* 2007**
"Eye compression is performed in order to initiate vagal hyperactivity. In individuals presenting with vagal hyperactivity, eye compression induces bradycardia or sinus arrest with clinical symptoms of varying severity". "The diagnosis of neurally-mediated syncope was not difficult on the basis of the clinical history, but the reproduction of syncope [by OC] reinforced the correct diagnosis".
– **Stephenson 2007**
"Aside from scientific exploration of the developing autonomic nervous system, the only current indication for diagnostic ocular compression is to induce a syncope so that its nature may be better understood".

## Special case of anoxic-epileptic seizures (epileptic seizures triggered by syncopes)

The term anoxic-epileptic seizure (AES) was coined for the situation where an anoxic seizure (a syncope) induces an immediate epileptic seizure (Stephenson 1983). The first case series was published by (Battaglia *et al.* 1989), with others following (Stephenson 1990, Stephenson *et al.* 2004, Horrocks *et al.* 2005).
When the diagnosis of AES is difficult to make on clinical grounds alone, OC may be helpful, as shown in *figure 1*. In that example, previously published in (Stephenson 1990), OC induced asystole and hence an epileptic seizure. Though the epileptic component of the AES was obvious on the EEG, its duration was rather short to have been diagnosed solely by clinical history (Horrocks *et al.* 2005).
Diagnostic difficulty is even greater when the epileptic component is absence status without absence epilepsy (Battaglia *et al.* 1989, Guerrini *et al.* 1991). Here are the latter authors' remarks *[with comments in square brackets]*.
– **Guerrini *et al.* 1991**
[referring to Battaglia *et al.* 1989] "the third patient (n° 2) had prolonged epileptic seizures in the form of absence status, triggered by ischemic (pallid syncope) cerebral anoxia. In all our patients, the lack of polygraphic monitoring during the attacks could indeed have led to misdiagnosis, prejudicing the beneficial effect that sodium valproate monotherapy showed in all cases, with suppression of the induced epileptic seizures. Particularly in the child with absence status, a pallid syncope followed by prolonged loss of consciousness without any consistent convulsive movement could hardly have been judged as epileptic upon clinical observation alone". "We wish to stress the importance of carrying out poylgraphic recordings, particularly in the less typical cases, in order to avoid dangerous misdiagnosis. With regard to this, we think that ocular compression may prove diagnostically helpful in cases with pallid syncope" [they referenced Stephenson 1983 and Battaglia *et al.* 1989].

## Summary and conclusions

In suggesting that the evidence arrayed in this editorial does not support the general use of OC in EEG your commentator may be accused of using a sledgehammer to crack a nut. However, it does seem important to support the proposition that OC during EEG (EEG with ECG, or EEG polygraphy) should be reserved for reproducing a clinical event, preferably with video control and/or a family member observing. When OC is used in this way it will aid family management and allow the diagnosis of atypical asystolic syncopes and in particular of AES when the epileptic component might be absence status.
Phonocardiography helped physicians and cardiologists better to appreciate and interpret the hearts sounds they previously only heard by auscultation. OC during EEG helped epileptologists and nonepileptologists to understand reflex syncopes previously known only by clinical history. But once these lessons are learned clinical medicine comes back to its prime position with its diagnostic abilities enhanced. □

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