ENG in the Emergency Room: Subtest Results in Acutely Dizzy Patients

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Abstract

A retrospective analysis of electronystagmography (ENG) subtests performed on 93 acutely dizzy patients in the emergency room (ER) shows that "pendular tracking" has high sensitivity and specificity for determining central pathology. Small combinations of subtests altered sensitivity or specificity only slightly over pendular alone. Detection of spontaneous nystagmus was also helpful in ruling out "other" diagnoses such as hyperventilation syndrome, psychogenesis, or malingering. Popularity of the shortened ENG in the ER was evidenced by the high rate of charting of results and the frequency with which the test was requested after the study terminated. ENG also identified four cases of previously unsuspected central nervous system (CNS) lesion.

Key Words: Dizzy, electronystagmography (ENG)

The present article reports the effectiveness of electronystagmography (ENG) subtests in determining categorical cause of dizziness in the emergency room (ER). Dizziness represents one of the most common primary complaints among ER admissions (Herr et al, 1989). The emergency physician must make an early decision whether or not to order an expensive work-up (computed tomography or magnetic resonance imaging) to rule out serious disorders. While most cases of dizziness presenting to the ER represent peripheral vestibular disorder, symptoms are often similar to those of central nervous system disorder, for which there is no simple test (Skiendzielewski and Martyak, 1980; Bonikowski, 1983; Hybels, 1984).

A previous prospective study (Herr et al, 1993) showed that a simplified ENG was highly sensitive and specific for determining central disorder in the ER. Because time and space are limited in this setting, a lengthy ENG is not feasible.

The current study retrospectively analyzes each subtest's ability to distinguish central

from peripheral pathology by comparing results with final 4-week diagnoses.

METHOD

Subjects

For use in both the previous prospective and current retrospective studies, 93 consecutive ER patients were enrolled with primary complaint of "dizziness" according to the criteria of Drachman and Hart (1972). Average patient age was 49.9 years (54 females and 39 males).

Procedures

Results of subtests were categorized according to the criteria below and compared blindly to the final 4-week diagnosis. Sensitivity and specificity were computed for each subtest as a determiner of "central" or "peripheral" pathology. In choosing the subtests, we considered time constraints and other limitations of the ER. Calorics were eliminated due to test time. Optokinetics were not included due to their usual low yield compared to other central tests, while positionals other than Hallpikes were excluded due to their generally nonlocalizing ability as to central versus peripheral (Coats, 1975). Tests selected included "spontaneous," "pendular tracking," "saccade," "gaze," and "Hallpikes."

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Final 4-week diagnosis was based on otolaryngologist reports in 16 patients, neurologist reports in 9 patients, private physician reports in 36 patients, and ER diagnosis by 4-week telephone follow-up in 32 patients. Since correct diagnosis was crucial, those not conforming to the specific criteria were categorized as "unknown." Criteria for determining final diagnoses are listed in Table 1.

ENG Method and Criteria

A small, single-channel ENG amplifier (Tracoustics RN 160) was utilized. Calibration, saccade, and gaze were performed using a manual visual target held by the patient to the bridge of the nose having horizontal markings at 10, 20, and 30 degrees from center gaze at a distance of 12 inches. Only horizontal testing was performed.

Pendular Tracking (Smooth Pursuit)

For portability, a small mechanical metronome was used as the visual target. A standard target speed of 40 degrees per second has been used in past experiments (Baloh et al, 1976). To achieve this speed subtending a visual angle of 45 degrees, a small circular paper target (¾ in.) was attached to the top of the pendulum, which, when set to "60 beats per minute," produced the desired speed when held 12 inches from the eyes. For some patients, greater success was obtained by using the examiner's finger or hand moving in a 10-inch diameter circle, two seconds per revolution with closest approach of the finger to patient's nose of 10 inches. This also provides the approximate target speed of 40 degrees per second.

Criteria for pendular were according to a four-type system first used by Benitez (1970) in which the tracing is visually interpreted. Since we felt the example drawings by Benitez are somewhat vague, we utilized the following descriptions and drawings (Fig. 1): Type I: smooth pattern; Type II: very minor intermittent non-nystagmus movements superimposed on smooth pattern; Type III: definite nystagmus or saccadic following (cogwheeling) superimposed on smooth pattern; and Type IV: complete loss of pattern. Types I and II were considered indicative of normal or peripheral lesion while Types III and IV were considered central.

Saccade

Horizontal saccade was performed by instructing the patient to look back and forth

Table 1 Criteria for Final Diagnosis

Diagnosis	Criteria
Central	
Tumor	Positive CT or MRI
Medication, alcohol, or drug related	History of taking a medication known to cause dizziness, positive toxicology screen, or clinical symptoms
Cerebellar infarct	CT or MRI
Multiple sclerosis	MRI
Miscellaneous	Appropriate clinical or objective studies
Peripheral	
Ménière's syndrome	Fluctuating sensorineural hearing loss, episodic vertigo, tinnitus
Acute labyrinthitis	Vertigo in setting of viral or postviral syndrome
Benign paroxysmal positioning vertigo	Vertigo to position change, transient, fatiguable
Peripheral vestibular	ENT consultant (includes hearing evaluation or appropriate studies as prescribed)
Miscellaneous	Appropriate clinical or objective studies
Other	
Vasovagal reaction	Near fainting, nausea, lightheadedness
Myocardial infarction	Two out of three of ECGs abnormal, typical chest pain, elevation of CPK-MB enzymes
Hyperventilation syndrome	Symptoms precisely reproduced by hyperventilation, with other testing negative
Psychogenesis	Psychiatric disturbance by clinical exam
Miscellaneous	Appropriate clinical or objective studies

CT = computed tomography; MRI = magnetic resonance imaging; ENT = otolaryngologist; ECG = electrocardiogram.

between the 20-degree calibration marks in response to verbal cuing at a speed approximating one eye movement per second.

Abnormalities including hypometric, hypermetric, or asymmetric saccade were considered central signs.

Gaze

The patient was instructed to gaze horizontally 30 degrees to the right, left, and center. Gaze was held with eyes open then closed for
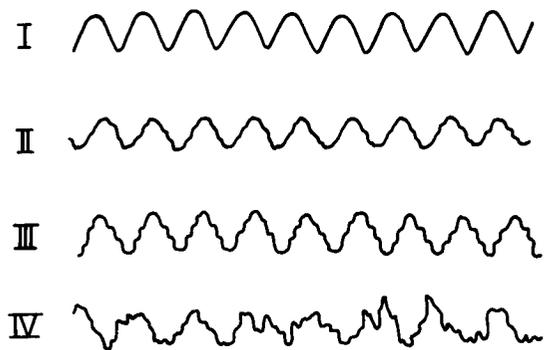
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Figure 1 Pendular tracking (smooth pursuit) patterns. Types I and II indicate normal; Types III and IV indicate central nervous system pattern.

several seconds utilizing a mental task (simple times tables).

Criteria were: (1) gaze nystagmus of peripheral type = direction fixed and follows Alexander's Law (Cyr, 1991), that is, upon lateral gaze toward fast component of significant spontaneous nystagmus (6 degrees/sec), nystagmus is enhanced and beating in that direction (particularly with eyes closed); or (2) gaze nystagmus of central type = gaze elicited nystagmus other than that described above.

Spontaneous

Tracing was obtained with the patient sitting or lying with head on a pillow. Patients with severe symptoms were sometimes encountered lying down and not required to sit up. These situations limited the ability to perform Hallpikes as explained below.

Criteria consisted of the following nystagmus types: (1) significant spontaneous nystagmus (eyes closed) = equal to or greater than 6 degrees per second (unidirectional), suppressible upon visual fixation; and (2) spontaneous nystagmus of "central type"= any of the following: (a) nystagmus that is unsuppressible by visual fixation; (b) nystagmus greater with eyes open than closed; (c) nystagmus only with eyes open; and (d) direction changing nystagmus (without change in body position).

Hallpikes

With eyes closed and head turned to the right or left at 45 degrees, the patient was brought from sitting to head hanging position. A mental alerting task was then begun. Nystagmus was recorded first with eyes closed. At approximately 15 seconds, the patient's eyes were opened and observed for possible rotatory

nystagmus. The patient was then sat up, and with eyes closed nystagmus was recorded. The procedure was repeated for the opposite side. Presence of a positive response (see criteria below) resulted in repeat testing on the same side to determine fatiguability. In certain cases, the patient's condition precluded Hallpikes or required a partial test in which the patient was brought from sitting to supine only. This variation has yielded acceptable results in a previous study (Katsarkas, 1987).

The following criteria were employed: (1) positive typical = positioning produces nystagmus that is transient, fatiguable (less or disappears on repeat trials), and latent (begins a few seconds after position is achieved); and (2) positive atypical = positioning produces nystagmus that does not fatigue, is not transient, or has no latency (Watson et al, 1981).

RESULTS

Of the 93 patients tested, final determined diagnosis according to criteria in Table 1 was "central" in 11 patients (12%), "peripheral" in 53 patients (57%), "other" in 9 patients (9.7%), and "unknown" in 20 patients (21.5%). Complete follow-up information was not obtained in 7 percent of the sample, who were also classified "unknown." Specific diagnoses are shown in Table 2.

Table 3 shows sensitivity and specificity of each subtest for determining central or peripheral disorder. For specificity calculations, all patients in groups not having the disorder in question were utilized. For example, for specificity of pendular in central disorder, the percentage of those with negative tests in all groups other than "central" was utilized.

Figure 2 shows examples of pendular tracings of two peripheral patients with Type I pendular (*A*); two peripheral patients with Type II pendular (*B*); two central patients with Type III pendular (*C*); and one patient with Type IV pendular (*D*).

Table 4 shows sensitivity and specificity for small combinations of subtests. For example, sensitivity and specificity were computed for the combination "abnormal pendular *or* gaze" as well as "abnormal pendular *and* gaze" as tests of central pathology. These analyses were made for combinations of the three best subtests in terms of sensitivity and specificity in each diagnostic group. As shown, the "or" combinations caused a slight increase in sensitivity over pendular alone but a decrease in specificity

Table 2 Specific Diagnoses of Patients

Classification	Diagnosis	n
Central	Cerebellar infarct	2
	Alcohol or drug toxicity	2
	Brain tumor	1
	Central nervous system concussion	1
	Hepatic encephalitis	1
	Hypertension	1
	Hyponatremia	1
	Multiple sclerosis	1
	Pseudotumor	1
	Total	11
Peripheral	Acute labyrinthitis	18
	Peripheral vestibular disorder	17
	Benign positional vertigo	7
	Ménière's disease	4
	Labyrinthine concussion	4
	Cervical disorder	2
	Serous otitis media	1
	Total	53
Other	Hyperventilation	3
	Psychogenesis	2
	Malingering	1
	Fumes intoxication	1
	Cystitis	1
	Migraine	1
	Total	9
Unknown	Total	20

Table 3 Sensitivity and Specificity of ENG Subtests for Determining Central and Peripheral Disorder

Final Diagnosis	Sensitivity (%)	Specificity (%)
Central (n = 11)		
Abnormal pendular	81.8	90.2
Abnormal saccade	27.3	96.7
Spontaneous nystagmus (central type)	9.1	98.3
Positive Hallpike (atypical)	25.0	88.5
Abnormal gaze (central type)	33.3	95.1
Peripheral (n = 53)		
Positive Hallpike (typical)	55.8	82.4
Positive Hallpike (atypical)	14.0	88.2
Abnormal gaze (peripheral type)	26.4	100.0
Spontaneous nystagmus	27.5	89.5

while "and" combinations had a slightly opposite effect.

We next determined whether the presence of a central sign along with the absence of a peripheral sign would increase sensitivity or specificity for central pathology and vice versa for the peripheral case (Table 4). Pairing the most successful central sign (abnormal pendular) with absence of the most successful peripheral sign (positive Hallpike) increased specificity slightly over pendular alone while sensitivity remained the same. Likewise for peripheral, abnormal Hallpike combined with normal pendular increased specificity slightly but decreased sensitivity compared to Hallpike alone. Combinations of tests, therefore, did not substantially improve sensitivity/specificity values.

Age and Pendular Tracking

The extent to which age alone affected pendular tracking was assessed by comparing the incidence of "abnormal" pendular tracking (Type III or IV) for noncentral patients in young (< 65 years) and older (> 65 years) patients. Incidence of abnormal pendular was 11 percent and 5 percent in the older and younger noncentral groups, respectively.

Spontaneous Nystagmus and Pendular Tracking

In order to determine the effect of spontaneous nystagmus on pendular tracking, we examined all cases of significant spontaneous nystagmus (greater than 6 degrees per second) to determine frequency of abnormal pendular. Of 16 such cases, 2 (12.5%) had Type III pendular or worse. Three other cases exhibited slightly nonsmooth tracings (Type II).

DISCUSSION

Since the major goal of the ER is to determine central pathology, sensitivity of the test in question for this etiology is crucial. Specificity, however, is also important since too many false positives would result in excess patient admissions. Subtests that best meet these criteria for detecting central pathology were "pendular," "pendular with normal Hallpike," and "pendular with absence of spontaneous nystagmus" (Table 4). In the previous
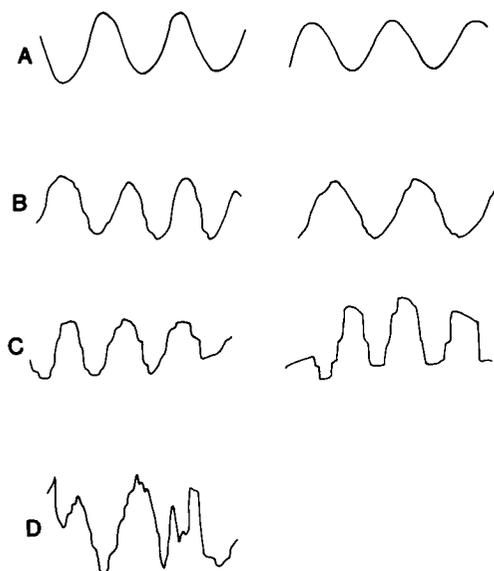
Figure 2 Example tracings of *A*, two "peripheral" patients with Type I pendular; *B*, two "peripheral" patients with Type II pendular; *C*, two "central" patients with Type III pendular; *D*, one "central" patient with Type IV pendular.

Table 4 Sensitivity and Specificity of Subtest Combinations for Determining Central or Peripheral Pathology

Final Diagnosis	Sensitivity (%)	Specificity (%)
Central (n = 11)		
Abnormal pendular *or* gaze	81.8	90.0
Abnormal pendular, gaze, *or* saccade	81.8	82.4
Abnormal pendular *and* gaze	33.3	100.0
Abnormal pendular, gaze, *and* saccade	11.1	100.0
Abnormal pendular *and* normal Hallpike	81.8	96.2
Abnormal pendular *and* absence of nystagmus	80.0	96.7
Peripheral (n = 53)		
Abnormal Hallpike *or* gaze (peripheral type)	68.0	75.0
Abnormal Hallpike, gaze (peripheral type), *or* spontaneous nystagmus	72.5	71.4
Abnormal Hallpike *and* gaze (peripheral type)	9.1	95.0
Abnormal Hallpike, gaze (peripheral type), *and* spontaneous nystagmus	0	100.0
Abnormal Hallpike *and* normal pendular	46.5	84.2

study (Herr et al, 1993), the subtests as a battery correctly identified central disorder at a sensitivity and specificity rate of 81.8 percent and 92 percent, respectively, including four cases missed by the physician's clinical diagnosis. In the present analysis, the same sensitivity was achieved by a single subtest, pendular tracking (81.8%), with nearly as high specificity (90.2%). Utilization of combinations of subtests for which experienced analysis is required is probably not indicated for this environment since our analysis shows that such combinations only minimally altered sensitivity and specificity over pendular alone. One concern in pendular testing is the possible contamination by spontaneous nystagmus or advanced age. Our analysis of these factors showed that these effects were small when using our "Type III" criteria for abnormal.

Peripheral subtests, while being high in terms of specificity, showed low sensitivity. Since finding peripheral disorder is less crucial in the ER, time spent on tests with low yield seems inappropriate in this setting and could best be left to outpatient clinics (Rosen et al, 1988).

Few patients with diagnosis of "other" showed abnormalities on ENG. This argues for routine assessment of spontaneous nystagmus since its presence would help rule out "other" diagnoses such as malingering, psychogenesis, or hyperventilation syndrome often seen in the ER.

It is noteworthy that few of our ENGs were normal. This may argue for performing ENG in the acute stages of dizziness since in our experience, a high percentage of ENGs are normal when performed long after the initial episode. This question deserves further study.

The delivery model for ENG in the ER is a topic for further investigation. It has been suggested that a technician could be trained to perform the test with the physician providing the initial reading and an "official" reading by the audiologist the following day. Such a model is followed in ECG with a cardiologist providing the "official" reading. In our experience, however, we have noted a need for considerable tester experience and have found it advantageous for the interpreter to also be the tester.

Popularity of the shortened ENG was demonstrated by frequent charting of results and requests for the test long after completion of the study. An additional application of the present data may be in the subspecialty clinic where audiologists need to weigh outcomes of various subtests with results that may conflict.

CONCLUSION

ENG subtests hold promise in the emergency room for initial categorization of dizziness as "central" or "peripheral." The single subtest pendular tracking showed high sensitivity and specificity for determining central pathology in this patient population. Detection of spontaneous nystagmus also appears useful in this setting to rule out nonvestibular causes of dizziness.

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