SUMMARY
AND
CONCLUSION
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Vestibular functions are of paramount importance in maintenance of balance while executing various movements throughout life. Pathology at any level in vestibular system leads to array of signs and symptoms and one of the most common being vertigo. Present study was carried out on 34 controls and 135 subjects in experimental group, suffering from vertigo to ascertain the functioning of vestibular system, its degree of lateralization, impairment and probable cause. Detailed history, clinical examination and investigations contributed greatly to know different diseases affecting vestibular system, when no obvious cause of dysequilibrium was determined. Electronystagmography and craniocorpography were the main vestibular function tests assessing vestibulo-ocular reflex and vestibulospinal system respectively.

Categorization of vertigo cases was done based on findings of clinical examination and the vestibular function tests into six subgroups depending mainly on the site of pathology. The subgroups were that of unilateral (left and right) and bilateral peripheral lesions, central lesion and mixed lesion (having peripheral as well as central pathology) and general medical disorders.
Following conclusions were drawn from the observations and findings of vestibular function tests conducted on experimental and control groups.

1. Disturbance in peripheral and central part of the system may often cause the same type of symptoms.

2. (a). Vertigo was commonly expressed as objective spinning, tendency to fall and swaying sensation apart from vague dizziness. (b). Some subjects with central and mixed lesion in addition to vertigo also complained of blackouts and pressure in head. (c). Certain medical disorders as fluctuations in blood pressure, diabetes, anemia, etc. can also incapacitate a person by causing severe vertigo.

3. Intermittent dizziness with sudden onset was common feature in subjects with peripheral lesion while continuous dizziness with gradual onset was experienced by many subjects with central lesion. The dizziness was short lived in peripheral lesions while prolonged in central lesion.

4. Hearing impairment and tinnitus was more common in peripheral lesion while ocular symptoms as diplopia, blurring, impaired vision and spots before eyes were manifested in subjects with central pathology.

5. Vegetative symptoms such as nausea and sweating were experienced in majority of subjects with peripheral lesion as compared to those with central lesion.
6. Abnormal saccades were more commonly seen in cases with central pathology especially in cerebellar lesions.

7. Eye tracking tests i.e. smooth pursuit and optokinetic tests could be performed smoothly and appropriately by most of the subjects at 20°/sec stimulus velocity as compared to 40°/sec stimulus speed. Majority of the subjects in all the groups either could not track or could do so inappropriately when target speed of the optokinetic stimulus was 40°/sec. Smooth pursuit was also affected at higher speed of stimuli and more so in central and mixed lesion group. Smooth pursuit was interrupted by saccades in central pathology especially in cerebellar disorders. Optokinetic responses showed minor asymmetry in control subjects, peripheral lesion group and general medical disorders group while gross asymmetry was seen to be a feature of central pathology.

8. Manifestation of spontaneous nystagmus suggests unequal inputs of impulses from vestibules. Presence of spontaneous nystagmus of low frequency even in some normal subjects suggests minor inequality in resting activity of each side of the paired receptors. Peripheral pathology manifested as spontaneous nystagmus in contralateral direction while in central pathology the direction of spontaneous nystagmus was not much helpful in locating the site of lesion. Secondly, spontaneous nystagmus cannot be observed with eyes open in peripheral lesion but could be see with eyes open in
majority of cases with central lesion apart from its presence in normal range with eyes closed.

9. Peripheral nystagmus is enhanced by closing the eyes, but a central nystagmus may be diminished with eyes closed.

10. Presence of gaze nystagmus in cases of central lesion indicated that gaze nystagmus was a feature only in central pathology.

11. Positional nystagmus was seen to be present in control group as well as in experimental group. Hence, positional test appears to be of least importance and significance in diagnosing the pathology of vertigo.

12. Caloric test appeared to be one of the most important batteries of tests in detecting the abnormality. (a) F value for various parameters of nystagmic beats suggested that only frequency, maximum slow phase velocity and amplitude were the reliable parameters in decreasing order for diagnosing a case. Latency, duration, canal paresis and directional preponderance were not much reliable. This could be because the former three parameters gave absolute values while the latter two gave relative values for the vestibular functions. It was also observed that canal paresis and directional preponderance do not have topographical significance. No significant relation between side of lesion and directional preponderance was observed. Frequency was considered the most reliable of the three former parameters, as personal error in quantifying
the nystagmic beats is minimum. Absolute values of latency and duration showed very high intersubjective variation and were not helpful in distinguishing abnormal from normal. (b) Comparing responses with cold and warm stimuli, latency with cold stimulus was shorter, the duration longer and frequency, maximum slow phase velocity and amplitude were more compared to warm response. All these findings suggested that cold is stronger stimulus than warm stimulus. (c) The affected ear in peripheral lesion showed hypo functioning as manifested by less frequency of nystagmus beats in calorigram. Areflexia or absent responses surmise severe functional abnormalities of end organ and/or central component. Hyperactivity was found to be a feature of central pathology. Although similar findings were seen in irritative peripheral lesions also. Nystagmus when present with eyes open was found in some cases with central but never in peripheral lesion. (d). Bithermal caloric responses were plotted on butterfly chart and subsequent coding was helpful in giving the status of vestibular functioning at a glance.

In cases where observation for spontaneous nystagmus, gaze test, positional test and eye tracking tests failed to reveal vestibular functioning. It was the calorigrams that, revealed abnormality of vestibular function. Hence, caloric test was considered the most important test during electronystagmography. Moreover, it also evaluates the vestibular functioning of each ear separately.
13. Vestibulospinal tests i.e. craniocorpography showed lot of variation for different parameters and were inconsistent with the published literature. 

a) Forward displacement and breadth of sway in stepping test was found to be within quoted normal range in all the subjects. Angle of deviation and body spin was also observed to be within normal range for most of the subjects except in a few with central pathology. 

b) Direction of body spin was on the same side as that of direction of deviation in majority of the subjects in central group (80%) and in experimental group (75%) while in few of the subjects direction of deviation and body spin was on opposite direction. Angle of deviation to the affected side in subjects with peripheral lesion was not found in all cases as quoted in published literature nor was the body spin seen to be on the side of deviation in all the subjects with unilateral peripheral lesion. Ipsilateral and contralateral deviations were observed in unilateral peripheral lesion group that is well supported by Claussen (1991). 

c) Anteroposterior sway and lateral sway in standing test in all the subjects was within normal quoted range.

Thus, vestibospinal functions as detected by craniocorpograms were not very different in experimental and control subjects except in some cases with central pathology. Hence, vestibulospinal tests have not been much helpful in detecting the abnormality.

Electronystagmogram findings were always correlated with the history, reports of special investigation (if available) and expert opinion
to reach the final diagnosis. Electronystagmography revealed proportionately more abnormalities in patients of experimental group whereas craniocorpography alone did not distinguish between experimental group and control subjects. Overall more patients of experimental group had at least one abnormal test result.

LIMITATIONS AND FUTURE RELEVANCE

Vestibular function tests as electronystagmography and craniocorpography have their own limitations.

1). Electronystagmograph cannot record rotatory nystagmus as it picks up change in electric potential due to movements of corneoretinal axis. In rotatory nystagmus this axis remains stationary and hence no change in corneoretinal potential occurs. Thus there is no recording.

2). In electronystagmography, positional test was not much helpful in identifying a disorder.

3). Caloric test cannot be conducted in cases of suppurative otitis media, perforation of tympanic membrane and fistulas. This test also causes lot of apprehension and discomfort in many patients.

4). Craniocorpography cannot be performed on patients with limb paresis or in severe vertigo.

5). Other tests such as rotational test, galvanic test and dynamic posturography are better tests in evaluating vestibulospinal functions but due to cost factor are not in vogue.
Inspite of the disadvantages of caloric test and vestibulospinal tests as craniocorpography, they are still conducted in most of the clinics due to cost effectiveness and they would continue to be used in future as the advanced and modern tests require sophisticated equipments, skilled personnel and maintenance which cannot be afforded by every clinic.

Moreover, electronystagmography has its own advantages that it provides a graphic record of eye movements. The records can be used for follow up, teaching, medicolegal cases and publications. Nystagmus too weak to be visible could be recorded with eyes closed as electronystagmograph permits registration of eye movements of 1°/sec.