Database of benign positional paroxysmal nystagmus

Quadro sinottico dei nistagmi posizionali parossistici

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Key words

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Parole chiave

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Summary

Classification of various manifestations of benign positional paroxysmal nystagmus, due to canalolithiasis or to cupulolithiasis, as a reaction to movements and to the site of detritus, is now possible due to the integration of theoretical knowledge (relationships between the semicircular canals and/or ampullae and the vestibulo-ocular pathways) with the forms of nystagmus induced when the head is placed in various positions. A comparison is made of results in patients examined in three Departments, during the past 3 years, and data presented in the literature. Findings are presented in a database which enables the clinician to compare the standard diagnostic manoeuvres (Dix-Hallpike, Pagnini-McClure, Rose) with results obtained by placing the head in alternative positions. This approach offers all the information needed to identify the site of onset and hence to formulate a correct diagnosis, thus directly indicating the most appropriate liberating or repositioning manoeuvre or – in the case of a suspected central lesion – to suggest further tests. Moreover, it is suggested that this table could become a useful tool for teaching purposes.

Riassunto

La catalogazione di reazioni nistagmiche parossistiche dovute a canalolitiasi o a cupolitiasi, in relazione ai diversi movimenti eseguiti ed alla sede dei detriti, è possibile grazie all'integrazione delle basi teoriche (rapporti tra le varie sedi dei canali e/o ampolle e le vie vestibolo oculari) con i diversi nistagmi ottenuti nell'assunzione delle varie posizioni del capo. Gli Autori hanno confrontato i risultati dei pazienti valutati negli ultimi 3 anni in 3 Istituti coinvolti nello studio e con i dati presenti in Letteratura. I risultati vengono proposti in una tavola sinottica che, partendo dalle singole manovre standard di posizionamento (Dix Hallpike, Pagnini McClure, Rose), consente di confrontare le risposte ottenibili anche in funzione delle manovre liberatorie. Tale sintesi fornisce le informazioni necessarie a comprendere la sede d'insorgenza e quindi a formulare una corretta diagnosi indirizzando al suo trattamento liberatorio o di riposizionamento più adeguato o agli eventuali ulteriori accertamenti nel sospetto di una patologia non periferica. Infine, a giudizio degli Autori, la sinossi può costituire un utile strumento didattico.

Introduction

The presence of vertigo induced by changes in head position, lasting a few seconds associated with paroxysmal symptoms, leads to a diagnosis of benign paroxysmal positional vertigo (BPPV) [1]. The manoeuvres to be carried out in order to evoke a nystagmus (Ny) and related symptoms are numerous but are, in essence, four slow manoeuvres (supine, Rose, right side, left side) and four fast (Dix-Hallpike right and left, and McClure right and left). In practice, the two slow lateral movements are often replaced, already in the initial stages, by the fast movements [2 3]. When carrying out these manoeuvres, for both the slow and fast removal of detritus, various types of Ny are induced, some of which have already been classified [4-6].

Attempts to find a relationship between paroxysmal positional nystagmus (PPNy) and the semicircular canals involved have long since been made, by various research groups. For instance, Cohen [7], reported that the contraction of a particular eye muscle could be induced by the stimulation of a specific semicircular canal, and Wilson and Melvill [8] showed that the plane of eye rotation was always parallel to the stimulated canal specifying the vestibular projections to the oculomotor nuclei. Furthermore, Gagek [9] showed the presence of inhibitory and excitatory neurones, within the rostral nucleus, related, respectively, to the contralateral and ipsilateral abducent motor neurones. Giannoni [10], more recently, added clear indications regarding the patho-physiological implications of these mechanisms.
Taking into account current knowledge on the lateral

and posterior semicircular canals, basing conjectures on personal experience and applying theoretical methods to canal-oculomotor interactions, the Authors attempted to verify whether there were univocal responses for each canal involved or for the various sections of each canal.
Aim of the present study is to provide the vestibologist with a tool with which to better understand positional Ny, classify the various manifestations and make a comparative assessment between results obtained from clinical tests and theoretical data. These combined data could, in our opinion, provide a useful tool, for teaching purposes.

Material and methods

Theoretical aspects start with oculomotor innervation (trineuronal arch) [7], the lever action of the extrinsic ocular muscles and the relationship with the stimulation/inhibition of the ampulla [11 12].
Furthermore, the instant triggering the reactions is related – at least from a theoretical point of view – to movement of the detritus within the canals or to an increase in the mass of the cupola [13].
In this study, Ny of stationary origin – but distinct from PPNy – were not included, even when induced in the classical positions.
The Dix-Hallpike manoeuvre was used for the vertical semicircular canals since it places the two anterior canals, on one side, and the two posterior canals, on the other, on the best plane for movement. The Pagnini-McClure manoeuvre, instead, was used for the lateral semicircular canals (LSC) (with the head leaning slightly forward in order to verticalize the plane). Adaptation was reduced to a minimum by allowing fairly long intervals between manoeuvres.
Starting with the study of a canal on one side, and hypothesizing the site of the detritus to be the cupula (utricular side) or the ampullar (Amp) or non-ampullar (N-Amp) extensions and that the movement takes place according to one or two oblique planes for the vertical canals or to one horizontal plane for the horizontal canals, the possible ocular movements were simulated separately for each eye, which manifest in paroxysmal Ny (PPNy), in Ny induced by the intermediate sitting position and in the releasing Ny. This was based on the assumption that detritus will move away from the ampullae in forms of canalo-lithiasis and towards the ampullae in forms of cupulo-lithiasis.
After having reviewed all possible events related to both the lateral canals and the posterior (PSC) and anterior (ASC) vertical canals, an assessment has been made of the involvement of multiple canals such as – and more frequently observed – in the crus (PSC + ASC on the same side) or, alternatively, of the same canal, but in separate ears.
All possible Ny reactions were recorded in a Table which was used as a database and filed according to various filters. A comparison was then made between the findings of others and personal observations in >2,000 patients with PPNy, studied in our Departments over the past 3 years.

Results and discussion

For clinical purposes, a database was created in which the primary key was based on standard manoeuvres routinely adopted in patients with a positive or suspected diagnosis of BPPV.
The data obtained in this study support our hypothesis that it is possible to identify the ear and site of the lesion by correlating all variations in responses to the plane of stimulation of the inducing and/or releasing manoeuvre.
In fact, reactions proved to be consistent for each of the single canals involved.
If the operator observes each eye separately, he/she will be able to see not only variations in the response on the different planes of ocular rotation but also the presence of a disjunction in relation to the pairs of ocular muscles involved, thus inducing distinctive PPNy for each single position [4 5 7 11]. These few examples of equivalent responses can be further broken down according to behaviour of ocular movement in opposite positioning and/or the releasing manoeuvre. This can be illustrated by two cases taken from Table I:

– after Hallpike's manoeuvre (right), if the Ny is very intense (++), rotatory anticlockwise (Rac), geotropic (G) in the right eye and vertical upwards (Vu++) in the left, there is a possibility that the site of the lesion may be the cupula or the non-ampullar (N-Amp) extension of the right posterior semicircular canal (PSC); in both cases, the detritus moves in an ampullifugal (Af) direction and will, therefore, induce a neuronal response of the excitatory type (+), classified as Af (+); returning to the upright sitting position, or to that opposite to the initial manoeuvre, will determine another Ny which is now rotatory clockwise (Rc+) geotropic (G), in the right eye, and vertical downwards (Vd+), in the left, unless in this latter position there is a release from symptoms which will result in a Ny classified as Rac++ apogeotropic (A) in the right eye and Rac++ (A) in the left due to the ampullifugal stimulation incurred on the ipsilateral anterior and posterior canals; in the case of a cupular lesion, the Ny will be Rc+ (G) in the right eye and Vd+ in the left.

If the detritus is found at crus level, we can observe an un-dissociated Ny of the two eyes (observation always to be seen in the primary gaze) and, more

specifically, if the finding is a Ny Rac+ (A) in the right eye and Rac+ (A) in the left eye, for the left ear in Hallpike left, with a similar, more intense reaction but tending on geotropic (G), for the right ear in Hallpike right, then we will have induced an ampullipetal-inhibitory movement (2Ap(-)) for the two canals in the first case and an ampullifugal-excitatory movement (2Af(+)) in the second; when returning to the sitting position or contralaterally, in relation to eye movement, the Ny is inverted due to inversion of the movement of the detritus giving apparently similar responses which differ as far as concerns geotropism, whereas with a liberating effect eye movement will differ as far as rotation is concerned but both manifestations will be apogeotropic (Rc++ (A)/right eye and Rc++ (A)/left eye vs Rac++ (A)/right eye and Rac++ (A)/left eye.

The concept of geotropism, stressed by some authors and which could be accepted as an explanation for horizontal Ny, is less applicable to rotatory Ny where in relation to unfavourable planes of stimulation. In Table I, geotropism is mentioned, but priority is given to the definition of horizontal eye movements Hr, Hl, Rc or Rac, Vu or Vd.

A certain amount of confusion may arise when referring to atypical Ny, oblique Ny or further when the Ny is confounded by multiple elements. Such Ny are not included in this Table, but, fortunately, they are not very significant. For all the other forms of Ny which have not been mentioned, our database is an attempt to offer a means of confrontation and a theoretical basis for further observations. The oblique or otherwise not classifiable Ny – which for latency, duration and paroxysm can be attributed to a peripheral event – could be considered to be the result of multicanal, phasic and dysphasic stimulation.

The Pagnini-McClure manoeuvre (right) can induce two types of Ny: horizontal left Hl (also defined as apogeotropic) or horizontal right Hr (or geotropic), whereas in the opposite position the direction of the Ny becomes the opposite. In such cases, the side of the lesion manifests a more intense geotropic component (non-ampullar side), and, inversely, less intense for the apogeotropic side: this confirms the second law of Ewald. At this point, attention must be paid to the differentiation between ampullar canalo-lithiasis and cupulo-lithiasis. The movement of detritus within the canals – that is, the possibility to transform an apogeotropic inhibitory Ny into a geotropic excitatory Ny – is a reliable method for this task.

A Dix-Hallpike's manoeuvre can evoke a series of reactions which can be classified into two main types: consensual and dissociated nystagmus. The first type includes bilateral rotatory Ny, which suggests the dual involvement of the ipsilateral anterior and posterior canals. In this group, the side of the lesion can be determined by the geotropic factor and by a more intense response (dual movement of the ampullipetal detritus: 2Ap (-)). In the opposite position, movements are inverted both as far as concerns direction and amplitude and in the releasing manoeuvre the Ny will always tend to be apogeotropic for all forms, on account of the movement of the detritus in an ampullifugal direction. Hence, the definition of the side of the lesion is univocal.

In the case of dissociated responses, owing to the fact that only one canal, anterior or posterior, determines the excitation or inhibition of separate groups of muscles which results in a rotatory movement of the more declivous eye in relation to the posterior canal and of the higher eye in relation to the anterior canal, whereas, in the opposite eye, the movement will be vertical (Vu++). This variant includes all those involving the ampullar side of the posterior canal. Only the cupular forms show a downward vertical (Vd+) Ny. Furthermore, ipsilaterally to the lesion, responses are more intense and tend towards geotropism, whilst on the non-ampullar side, behaviour more closely resembles the previous group. These forms have been included in Table I with a theoretical, rather than practical, reconstruction of the various phases.

In the case of involvement of the anterior canal, behaviour varies depending upon whether the lesion is on the same, or the opposite, side in relation to the Dix-Hallpike manoeuvre. In the first case, the resulting Ny is similar to that induced by lesions of the contralateral PSC, except for intensity and for direction – Vertical downwards (Vd++), for forms of canalolithiasis of ampullar origin, and upwards (Vu+) for forms of non-ampullar origin. In the latter case, the declivous eye has a vertical downward (Vd) direction and is fairly ample. Also in this group, this abnormal behaviour is caused by the involvement of the canal on the non-ampullar side which should always coincide with the crus commune for the dual involvement of the posterior canal. Here again, reconstruction of the various phases can be considered more theoretical than practical.

Table I includes some types of Ny evoked in the position of Rose: vertical Ny. When the basic definitions related to paroxysmal Ny are used for classification (latency, etc.), the latter Ny can be considered to differ from those described in the literature due to the axial involvement of the SNC. They are determined by the activation/inhibition of opposite pairs of PSC/A. Even in such cases, at first glance, responses are univocal, if compared under different positions.

By means of the theoretical reconstruction of the Ny and from a comparison with those obtained in routine clinical practice, findings coincided perfectly, particularly for the posterior (PSC) and lateral (LSC) canals; for the Ny induced by stimulation of various

Table I. PPNy database.

Manoeuvre of	PPNy		Pathologic side	Site	Detritus movements	Canal	Ny after return in sitting position		Opposite positioning Ny		Liberatory Ny (ampollifugal)		Mod. after Baloh
	R. eye	L. eye					R. eye	L. eye	R. eye	L. eye	R. eye	L. eye	
P-McC R	HL+ A	HL+ A	R	Cupula	Af(-)	LSC	======	======	HR++ A	HR++ A	HR++ A	HR++ A	No
P-McC R	HL+ A	HL+ A	R	Amp	Af(-)	LSC	======	======	HR++ A	HR++ A	Before transf.	in N-Amp	Yes
P-McC R	HR++ G	HR++ G	R	N-Amp	Ap(+)	LSC	======	======	HL+ G	HL+ G	HL+ G	HL+ G	Yes
P-McC L	HR+ A	HR+ A	L	Cupula	Af(-)	LSC	======	======	HL++ A	HL++ A	HL++ A	HL++ A	No
P-McC L	HR+ A	HR+ A	L	Amp	Af(-)	LSC	======	======	HL++ A	HL++ A	Before transf.	in N-Amp	Yes
P-McC L	HL++ G	HL++ G	L	N-Amp	Ap(+)	LSC	======	======	HR+ G	HR+ G	HR+ G	HR+ G	Yes
D-Hall R	Rac++(G)	Vu++	R	Cupula	Af(+)	PSC	Rc+	Vd+	Rc+ (G)	Vd+	Rc+ (G)	Vd+	=====
D-Hall R	Rac++(G)	Vu++	R	Amp	Af(+)	PSC	Rc+	Vd+	Rc+ (G)	Vd+	Rac++ (A)	Rac++ (A)	=====
D-Hall R	Rc+ (A)	Vd+	R	N-Amp	Ap(-)	PSC	Rac++	Vu++	Rac++	Vu++	Rac++ (A)	Rac++ (A)	=====
D-Hall L	Vu++	Rc++ (G)	L	Cupula	Af(+)	PSC	Vd+	Rac+	Vd+	Rac+ (G)	Vb+	Rac+ (G)	=====
D-Hall L	Vu++	Rc++ (G)	L	Amp	Af(+)	PSC	Vd+	Rac+	Vd+	Rac+ (G)	Rc++ (A)	Rc++ (A)	=====
D-Hall L	Vd+	Rac+ (A)	L	N-Amp	Ap(-)	PSC	Vu++	Rc++	Vu++	Rc++ (A)	Rc++ (A)	Rc++ (A)	=====
D-Hall L	Vd++	Rac++(A)	R	Amp	Af(+)	ASC	Vu+	Rc+	========	========	Before transf.	in N-Amp	=====
D-Hall R	Rc++ (A)	Vd++	L	Amp	Af(+)	ASC	Rac+	Vu+	========	========	Before transf.	in N-Amp	=====
D-Hall L	Vu+	Rc+ (G)	R	N-Amp	Ap(-)	ASC	Vd++	Rc++	Rc+ (A)	Rc+ (A)	Rc++ (A)	Rc++ (A)	=====
D-Hall R	Rac+ (G)	Vu+	L	N-Amp	Ap(-)	ASC	Rc++	Vd++	Rc+ (G)	Rc+ (G)	Rac++ (A)	Rac++ (A)	=====
D-Hall R	Vd++	Rac++(G)	R	Amp	Af(+)	ASC	Vu+	Rc+	========	========	Before transf.	in N-Amp	=====
D-Hall L	Rc++ (G)	Vd++	L	Amp	Af(+)	ASC	Rc+	Vu+	========	========	Before transf.	in N-Amp	=====
D-Hall R	Vu+	Rc+ (A)	R	N-Amp	Ap(-)	ASC	Vd++	Rac++	Rac++ (A)	Rac++ (A)	Rac++ (A)	Rac++ (A)	=====
D-Hall L	Rc+ (G)	Vu+	L	N-Amp	Ap(-)	ASC	Rac++	Vd++	Rac++ (G)	Rac++ (G)	Rc++ (A)	Rc++ (A)	=====
D-Hall R	Rc+ (A)	Rc+ (A)	R	Crus	2Ap(-)	PSC+A	Rac++	Rac++	Rac++ (A)	Rac++ (A)	Rac++ (A)	Rac++ (A)	=====
D-Hall L	Rac+ (A)	Rac+ (A)	L	Crus	2Ap(-)	PSC+A	Rc++	Rc++	Rc++ (A)	Rc++ (A)	Rc++ (A)	Rc++ (A)	=====
D-Hall R	Rac++ (G)	Rac++ (G)	R	Crus	2Af(+)	PSC+A	Rc+	Rc+	Rc+ (G)	Rc+ (G)	Rac++ (A)	Rac++ (A)	=====
D-Hall L	Rc++ (G)	Rc++ (G)	L	Crus	2Af(+)	PSC+A	Rac+	Rac+	Rac+ (G)	Rac+ (G)	Rc++ (A)	Rc++ (A)	=====
Rose	Vu++	Vu++	R+L	Amp/Cup	Af(+)/Af(+)	PSC+P	Vd+	Vd+	Vd+	Vd+	Vu++	Vu++	=====
Rose	Vd++	Vd++	R+L	Amp/Cup	Af(+)/Af(+)	ASC+A	Vu+	Vu+	Vu+	Vu+	Vd++	Vd++	=====
Rose	Vu+	Vu+	R+L	Amp/Cup	Ap(-)/Ap(-)	ASC+A	Vd++	Vd++	Vd++	Vd++	Vd++	Vd++	=====

Abbreviations and symbols:

Vu+	Vertical Ny up	HL	Horizontal left	(A)	Apogeotropic stance	(+)	Excitatory	Si	Straight inferior
Vu++	Vertical Ny up+	Rc	Rotatory clockwise	(G)	Geotropic stance	Sm	Straight medial	Ss	Straight superior
Vd	Vertical Ny down	Rac	Rot. Anticlockwise	Ap	Ampullipetal	Sl	Straight lateral	Amp	Ampullar side
HR	Horizontal right	A	Apogeotropic	Af	Ampullifugal	Oi	Oblique inferior	N-Amp	Non-ampullar side
		G	Geotropic	(-)	Inhibitory	Os	Oblique superior	Cup	Cupular side

sites within the ASC or that of the association of multiple canals – since few references have appeared in the literature – more work still needs to be done in order to be able to give a realistic assessment. Hence, at present, our opinion can only be based on theoretical suppositions.
A considerable number of rotatory PPNy have been identified, both ipsi- and contralateral, and will be the topic of a forthcoming publication; all were induced by positioning of the detritus within the crus commune. In the literature, mention is often made simply to PPV of the PSC. This is due to the type of relationship that exists between the semicircular canals and the ocular pairs and, in particular, this includes the stimulation and inhibition of both the posterior and the anterior canal ipsilaterally, which results in a rotatory movement of both eyes.

Conclusions

The study of the relationships between projections leading from various sites within the canals and vestibulo-ocular reflexes leads to typical forms of Ny which, when compared to those obtained under various specular or releasing positions, lead, in turn, to sequences typical for each semicircular canal and the specific section involved. These are outlined in Table I. Manipulation of the database enables the clinician to read the data from any point of view. In particular, starting from the manoeuvre itself, the Table can be interpreted in such a way as to identify the various possible responses that can be induced, making it easier to understand which site and which side is responsible for the clinical signs. This synoptic table can be used as a comparative tool and for reference in various protocols, in particular in multicentre studies which require a common denominator for classification.

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