

Vestibular Disorders in the Pediatric Age: Retrospective Analysis and Review of the Literature

Patologia Vestibular em Idade Pediátrica: Análise Retrospectiva e Revisão da Literatura



António Fontes LIMA^{✉1}, Filipa Carvalho MOREIRA¹, Ana Sousa MENEZES¹, Isabel Esteves COSTA¹, Cátia AZEVEDO¹, Sérgio VILARINHO¹, Luís DIAS¹
Acta Med Port 2021 Jun;**34**(6):428-434 • <https://doi.org/10.20344/amp.13147>

ABSTRACT

Introduction: Vestibular disorders in pediatric patients is still a controversial subject but has gained relevance over the years. In recent studies, its prevalence varied between 0.7% and 15%. Nevertheless, the true prevalence can be underestimated given that its clinical presentation is expressed compared to adults; it can present as rotatory vertigo, but it can also cause vision complaints, headaches, motor delay, and learning disability. Although middle ear effusion is considered the main cause of vestibular dysfunction in this age group, other diagnoses should be considered. The aim of this study was to describe clinical features of the pediatric population referred to a subspecialist Otorhinolaryngology vertigo clinic in a tertiary hospital between 2013 and 2017. We also aimed to compare the results and carry out a literature about the most common causes, diagnostic features and treatment approach.

Material and Methods: Clinical records of patients referred to a subspecialist Otorhinolaryngology vertigo clinic with suspicion of vestibular dysfunction aged between 0 and 18 years old were reviewed. Patients with middle ear effusion were excluded.

Results: Thirty-seven patients met the inclusion criteria. From these, 59% were female, with a mean age of 10.9 years old during the first consultation. The most common reason for referral was rotatory vertigo. Nausea and headache were also frequent complaints in our population. All patients performed audiometry; videonistagmography was performed in 41% of the cases; imaging studies were done in 59% of patients. The most common causes of vestibular dysfunction were vestibular migraine and benign paroxysmal vertigo of childhood (both in 27% of the cases), followed by vestibular neuritis (in 22% of the cases).

Discussion: Although our findings partially concur with the literature, compared with other specialist centers, the range of reasons for referral and of conditions is not as diverse, which may suggest that there is underdiagnosis of vestibular dysfunction in this age group.

Conclusion: Vestibular dysfunction in the pediatric age can have several causes; pediatricians, neurologists, physiatrists, family doctors and otorhinolaryngologists must be aware of the different forms of presentation. Referral and evaluation protocols addressing pediatric patients should be created.

Keywords: Benign Paroxysmal Positional Vertigo; Child; Migraine Disorders; Vertigo; Vestibular Diseases; Vestibular Neuritis

RESUMO

Introdução: A patologia vestibular na população pediátrica é um tema bastante controverso, mas que tem ganho cada vez mais destaque. A prevalência reportada nesta população varia entre 0,7% e 15%. No entanto, este valor pode estar subestimado, uma vez que a sua forma de expressão na população pediátrica é muito diferente da dos adultos, podendo ir desde a vertigem rotatória até queixas de alterações da visão, cefaleias, atraso motor ou dificuldades na aprendizagem. Embora na literatura a otite média com efusão seja considerada a principal causa de disfunção vestibular nesta faixa etária, existem outras que devem ser consideradas. O objetivo deste estudo foi descrever as características clínicas da população pediátrica encaminhada para avaliação em consulta de Otorrinolaringologia num hospital terciário, por suspeita de disfunção vestibular, desde o ano de 2013 até 2017; Também se pretendeu comparar os resultados e realizar uma revisão da literatura acerca das etiologias mais frequentes, características diagnósticas e abordagem terapêutica.

Material e Métodos: Foram analisados de forma retrospectiva os processos clínicos dos doentes observados na consulta de subespecialidade de Vertigem de Otorrinolaringologia com idades entre 0 e 18 anos. Foram excluídos os doentes com diagnóstico de otite média com efusão.

Resultados: Cumpram os critérios de inclusão 37 doentes, dos quais 59% eram do sexo feminino, sendo a idade média da primeira consulta de 10,9 anos. O motivo mais frequente de referência foi a vertigem rotatória. As náuseas e cefaleias foram também sintomas frequentemente descritos. Todos os doentes foram submetidos a audiometria tonal; a videonistagmografia foi realizada em 41% dos casos; exames de imagem foram realizados em 59% dos doentes. No que respeita às etiologias do quadro, as mais frequentes foram a enxaqueca vestibular e a vertigem paroxística benigna da infância (ambas em 27% dos casos), seguida da neuronite vestibular (em 22% dos casos).

Discussão: Embora os resultados sejam, em parte, sobreponíveis à literatura, comparativamente a outros centros de referência a diversidade de motivos de referência e de patologias é menor, o que pode apontar para o subdiagnóstico da disfunção vestibular nesta faixa etária.

Conclusão: A disfunção vestibular em idade pediátrica pode ter uma multiplicidade de etiologias, pelo que pediatras, neurologistas, fisiatras, médicos de família e otorrinolaringologistas devem estar alerta para as diversas formas de apresentação desta entidade. Deverão ser criados protocolos de referência e avaliação adequados para esta população.

Palavras-chave: Criança; Doenças Vestibulares; Neuronite Vestibular; Perturbações de Enxaqueca; Vertigem; Vertigem Paroxística Posicional Benigna

1. Serviço de Otorrinolaringologia e Cirurgia Cérvico-facial. Hospital de Braga. Braga. Portugal.

✉ Autor correspondente: António Fontes Lima. antoniofonteslima24@gmail.com

Recebido: 17 de novembro de 2019 - Aceite: 27 de janeiro de 2020 - Online issue published: 01 de junho de 2021

Copyright © Ordem dos Médicos 2021



INTRODUCTION

Symptoms related to vestibular disorders (VD) are uncommon in children and adolescents, with a prevalence ranging between 0.7% and 15%.¹ However, this may underestimate their true prevalence, considering that VD affecting the paediatric population have a different presentation from those affecting adult patients.²

Signs and symptoms of paediatric VD may vary from visual changes, headache, impaired gait coordination, motor delay, learning impairments and rotational vertigo while, in some cases, no clinical manifestations were found. On the other hand, according to some authors, the close anatomical relationship between the cochlea and the vestibular structures can explain why many children with sensorineural hearing loss present with some degree of VD.³

In addition to the difficulty in interpreting symptoms, the physical examination in this population has limitations (namely as regards collaboration) which may lead to misdiagnosis, in some cases, or to no diagnosis at all.¹⁻³

Vestibular testing that are usually used in adults, even though mostly used for the assessment of paediatric patients, require adaptations in terms of not only delivery, but also regarding normality values.^{2,4}

Despite the technological advances in the development of vestibular testing, history and physical examination remain a crucial element of diagnosis, which is a different process from those in adults and there are some pathologies that are unique to this age group.^{1,3,5}

Although otitis media with effusion has been described in literature as the main cause of VD in children, other causes must be considered, including benign paroxysmal vertigo of childhood (BPVC), vestibular migraine (VM) and traumatic brain injury (TBI).^{1,5} Less common causes include vestibular neuritis (VN), labyrinthitis, benign paroxysmal positional vertigo (BPPV), Ménière's disease and central nervous system tumours. Psychogenic vertigo should also be taken into account.⁵

This study was aimed at the analysis of paediatric patients attending the vertigo outpatient clinic at a tertiary hospital, including their forms of presentation, physical examination and testing, in addition to most frequent aetiologies. Subsequently, a revision on the most appropriate and current literature on the subject has been made.

MATERIAL AND METHODS

This was a retrospective study of a series of cases, involving patients of paediatric age (aged between 0 and 17 years and 364 days) referred between 2013 and 2017 to the vertigo subspecialty outpatient clinic (ear, nose & throat - ENT - department) at the Hospital de Braga (HB). Data included patient's gender, age of symptom onset, detailed clinical history, major symptoms at presentation, otoneurological examination (presence of spontaneous nystagmus with the use of Frenzel goggles, head impulse test (HIT), oculomotricity, Romberg test, Unterberger-Fukuda (UF) test and the presence of positional nystagmus), the results of the cochleovestibular assessment testing (tonal audiometry

and videonystagmography), imaging tests [computed tomography (CT) scan and/or magnetic resonance imaging (MRI)] and diagnosis.

Patients diagnosed with otitis media with effusion (OME) were excluded from this study.

The study protocol was approved by the Ethics Committee for Health of HB.

RESULTS

Inclusion criteria were met by thirty-seven patients [59% female (n = 22); mean age at first consultation was 10.9 ± 3.7 years, ranging from 4 to 17 years]. Results are shown in Tables 1 and 2.

Rotational vertigo was the main reason for referral, mostly associated with nausea (46%, n = 17), headache (35%, n = 13), vomiting (24%, n = 9), visual disturbances (16% n = 6) and transient hearing loss (5%, n = 2).

Different abnormalities were found in physical examination: spontaneous nystagmus was found in 16% of the patients, positional nystagmus in 16%, positive HIT in 27%, UF test showing a significant deviation in 24% and Romberg test showing instability and/or falling in 21% of the patients.

All patients underwent tonal audiometry, which was normal in all of the patients, with a 12.1 decibels (dB) ± 4.3 average of the tonal airway threshold on the right ear and 12.7 dB ± 5.7 on the left.

Videonystagmography (VNG) was carried out in 41% of the patients (n = 15) and abnormalities were found in four patients, namely those related to unilateral vestibular hypofunction.

Imaging (CT scan and/or MRI) was carried out in 59% of patients and abnormalities were found in only one patient.

VM and BPVC were mostly found (both in 27% of the patients), followed by VN (22%) and BPPV (16%).

VM was predominantly found in female patients (mean age at first consultation of 12 years ± 1.6) and all the patients presented with headache, 70% with nausea and 40% with visual abnormalities before or during the crisis, with no abnormalities in physical examination. VNG abnormalities related to unilateral vestibular hypofunction were found in only one patient and all the patients were submitted to imaging tests (requested by ENT or neuropaediatrics). Symptom control at the time of the crisis was obtained with analgesics and anti-emetics. Prophylactic drugs, namely flunarizine (5mg/day) and amitriptyline (1 mg/kg/day) were effective in only two patients presenting with frequent crises (more than once a week). All the patients in this group simultaneously attended the neuropaediatrics outpatient clinic.

BPVC was frequently diagnosed (mean age at first consultation of 5.8 ± 1.7 years – range 4-8) even though none of the patients was examined during the crisis and physical examination and cochlea-vestibular testing were normal in all the patients. Only one patient underwent imaging tests (prior to referral to ENT consultation), which were normal. These patients were followed for between three and four

Table 1 – Characteristics of our group of patients at presentation

Average age at presentation	10.89 years	
Gender (Female/ Male)	59% (n = 22)/ 41% (n = 15)	
Symptoms at presentation	Rotational vertigo	100% (n = 37)
	Nausea	46% (n = 17)
	Headache	35% (n = 13)
	Vomiting	24% (n = 9)
	Visual disturbances	16% (n = 6)
	Hearing loss	5% (n = 2)
Abnormal data in otoneurological examination	Spontaneous nystagmus	16% (n = 6)
	Positive HIT	27% (n = 10)
	Positive Romberg test	21% (n = 8)
	Unterberger-Fukuda stepping test showing deviation or rotation	24% (n = 9)
	Positional nystagmus	16% (n = 6)
Tests: patients submitted to the test / patients with abnormal test	Tonal and vocal audiometry	100% (n = 37)/ 0%
	Videonystagmography	41% (n = 15)/ 10% (n = 4)
	CT-scan or MRI	59% (n = 22)/ 2.7% (n = 1)

Table 2 – Diagnosis, average age at first examination

	%	n	Age (years)
Vestibular migraine	27%	10	12.0
Benign paroxysmal vertigo of childhood	27%	10	5.8
Vestibular neuritis	22%	8	14.4
Benign paroxysmal positional vertigo	16%	6	13.0
Psychogenic	5%	2	14.5
Multiple sclerosis	3%	1	16.0

years, with a reduction in crisis frequency over time and subsequent resolution of the condition, with no crises for more than a year in all cases before discharge.

VN was also a frequent reason for referral (mean age at diagnosis of 14 ± 2.2 years). In our population, at the first medical examination and after clinical diagnosis, all patients were admitted for systemic corticosteroid therapy due to severe symptoms and were discharged after symptom improvement and referred to the vertigo outpatient clinic. All were submitted to imaging tests, showing no relevant abnormalities. These were subsequently submitted to caloric tests, which showed recovery of the vestibular hypofunction in all cases except one, which was referred to vestibular rehabilitation using a posturography platform, due to persistence of balance abnormalities.

Regarding BPPV, the physical examination findings were crucial: one patient presented with BPPV of the lateral semicircular canal (SCC), diagnosed by the McClure manoeuvre; another patient presented with BPPV of the anterior SCC, with nystagmus at Rose's manoeuvre (head-hanging test); the remaining patients presented with BPPV of the posterior SCC, with nystagmus at Dix-Hallpike manoeuvre. In our population, Lempert's manoeuvre was used for lateral CSC BPPV, Yacovino's manoeuvre for anterior CSC BPPV and Epley's manoeuvre for posterior CSC BPPV.

Two female adolescent patients with a history of psychi-

atric pathology who were referred due to a condition classified as vertigo, which mainly occurred in distress situations, were also included; after evaluation, in which both physical examination and cochleovestibular examination were normal, with normal MRI, their condition was classified as psychogenic vertigo.

Finally, one of the patients, a 16 year-old adolescent, was referred to the vertigo clinic by the emergency department. At that time, the patient presented with what was diagnosed as an acute vestibular syndrome, with associated vertigo, nausea and vomiting; however, the patient also had a previous history of a right-sided hemiparesis episode with unknown aetiology and with spontaneous resolution. The physical examination showed spontaneous horizontal jerk nystagmus, HIT showing no catch-up saccades and the remaining otoneurological examination was normal.

DISCUSSION

Even though different presentations of paediatric VD are shown in literature, rotational vertigo was the main symptom underlying the referral of our group of patients, in line with Szirmai who also described vertigo as the most frequent reason for referral of paediatric patients with suspected VD.⁶ In addition, nausea, vomiting and headache were frequently associated, in line with similar studies.⁶⁻⁸

The fact that a different reason for referral has been

found in our population may have been due to the lack of knowledge of the forms of presentation of vestibular pathology at this age; referring physicians usually associate this with rotational vertigo. However, this is not a frequent presentation, even though vertigo is typical of acute unilateral peripheral vestibular hypofunction, in patients with chronic hypofunction.⁹ Apart from vertigo, also imbalance, delayed motor development or visual impairment are often found in VD affecting paediatric patients, as shown in most recent literature. Persistent clingy behaviour, asking to be held, refusal to get up or frequent falls could correspond to signs of VD at an even earlier age.^{2,5,9,10}

As far as referral centres are concerned, the reality is different as regards the reasons why referring physicians suspect the presence of a VD and, on the other hand, the reasons for ENT assessment of the vestibular system, as opposed to what happens in our population. Delayed motor development has been described by O'Reilly *et al.* as one of the main reasons for referral to the paediatric vertigo outpatient clinic by developmental paediatricians, physiatrists and neurologists; on the other hand, patients presenting with syndromes that may be associated with vestibular disorders (including Usher syndrome, Waardenburg syndrome, etc.) are systematically evaluated in this setting; finally, all patients with confirmed sensorineural hearing loss (SNHL) are usually submitted to a comprehensive study of the vestibular system, as 38-91% of the patients with SNHL present with some type of VD, according to recent studies, depending on the aetiology and degree of hearing loss; examples of the latter are the different current protocols of pre-implantation cochlear evaluation that include the evaluation of the vestibular system.^{2,3,11}

Vestibular assessment may be a difficult task in paediatric age, for a number of reasons: at this age, the ability to self-perceive symptoms or identify them as abnormal may be difficult; on the other hand, the lack of cooperation in the physical examination and testing have an impact on its performance.²⁻⁵ Nevertheless, physical examination, including an adequate otoneurological assessment, is crucial to establish the most likely diagnostic hypotheses and to the best approach.

A comprehensive cochleovestibular evaluation is very relevant in the presence of these symptoms. Tonal audiometry, together with impedance audiometry, are relevant for the differential diagnosis. On the other hand, caloric tests (integrated in videonystagmography) are still considered the gold-standard for assessing the vestibular system,^{9,12} providing information on the upper vestibular nerve branch and the horizontal semicircular canal and with sensitivity even for mild vestibular dysfunctions.¹² However, compliance is quite dubious, especially in children under the age of six, as attention from the examinee is required and could become uncomfortable, as irrigation of the external auditory canal is required.^{2,9,12}

The abovementioned tests have mostly been used in our department, as they were available at the time when the study took place. Some tests have been gaining rele-

evance and are used in different centres. Clinical assessment protocols of vestibular symptoms were described by Dhont *et al.*, according to the patient's age and including the video-head impulse test (vHIT), cervical vestibular evoked myogenic potentials (cVEMP) and ocular vestibular evoked myogenic potentials (oVEMP) apart from those described.² These tests allow for a comprehensive and specific assessment of the vestibular system - the vHIT test allows for the assessment of each of the semicircular canals; cVEMP allows for the assessment of the saccules and oVEMP of the utricle.^{9,12} As a whole, these allow for the evaluation of all end-organs of the vestibular system. These are used by different authors in the approach to patients from the age of six months onwards, even though testing methodology should be adapted to the paediatric age.^{2,12}

Neuroimaging tests have a questionable value.¹³ CT-scan is rarely useful, according to literature (even though it may be useful, for example, when a temporal bone fracture is suspected due to its better bone definition); on the other hand, MRI is first choice whenever structures such as the posterior fossa or the inner ear are to be assessed.^{7,13} In addition, imaging may have an indication in patients with vertigo and associated neurological deficits or persistent headache.¹³ However, apart from their high costs, the patient's cooperation is required or the anaesthesiology support (for sedation or general anaesthesia). In our population, although a large number of patients were submitted to these tests, abnormalities associated with a demyelinating disease were only found in one patient, which was later confirmed as multiple sclerosis. The high percentage of patients who underwent these tests in our population can be explained by the groups diagnosed with VM and VN, which together represented around 50% of the patients, all of whom underwent imaging examinations.

In our population, VM, BPVC, VN and BPPV were most frequently found, in line with different authors, with VM and BPPV as the leading causes of VD in paediatric age.^{6-8,14,15} The percentage differences may be due to different methodologies, as well as inclusion and exclusion criteria; for example, only the paediatric population with a chief complaint of vertigo was included in some studies^{6,8,15} while all the patients under the age of 18 referred to vestibular outpatient clinic, regardless of the main symptom, were included by O'Reilly *et al.*¹⁶ In addition, patients diagnosed with OME were excluded from most studies, due to the great variability in the presentation of patients with VD in these cases.^{6,8,14,15}

Vestibular Migraine

The diagnosis of VM is based on criteria that were well defined by the International Headache Society (Table 3).¹⁷ According to Davitt *et al.*, this pathology can be associated with up to 35% of the paediatric population presenting with vertigo, with less relevance in adults (responsible for less than 7% of adults with vertigo).¹⁸ These were also found in our group of patients, showing VM as one of the leading causes.

On the other hand, VM's pathophysiology is still quite controversial.¹ Patients usually present with recurrent vestibular symptoms associated with migraine (before, during or after), with a duration ranging between five minutes and 72 hours; some children also present with photo and phonosensitivity. The physical examination is usually normal between crises and patients usually remain asymptomatic.⁵

Although non-pharmacological treatment (through avoidance of triggers) is the first line of approach at this age, there are pharmacological options. During the crisis, analgesic and antiemetic drugs are usually effective, while the remaining options can be subdivided into abortive, used during the acute crisis, and prophylactic; these should be used when crises are frequent, once a week or more, or when crises are debilitating or prolonged and according to the physician's preference.^{1,5,10,18} Calcium channel blockers and triptan drugs are most commonly used; anticonvulsants, including topiramate and gabapentin, and tricyclic antidepressants, such as amitriptyline, also appear to be effective in crisis prophylaxis; however, since there are no studies on the use of these drugs in paediatric age, treatment has been based on adult guidelines.⁵

Benign paroxysmal vertigo of childhood

BPVC was frequently diagnosed in our group of patients (27%), while it was found in 12-26% of the paediatric population presenting with vertigo in other studies.^{1,5} Symptoms usually start at an early age (1-4 years of age), in line with our group of patients, with a self-limited course and rarely beyond the age of 8.¹ Therefore, treatment is symptomatic (with antiemetic drugs), whenever required; its benign nature must also be explained to parents.⁵

It is characterised by sudden episodes of vertigo, with unexpected onset, no prodromal symptoms, lasting seconds to minutes and associated with spontaneous nystagmus at this stage.⁵ It is considered a pathology of central origin, within the migraine spectrum.¹⁷ Since there is some overlap between BPVD and VM, some authors acknowledge that the former may, in fact, be a precursor of the latter.^{5,7,15,17}

Benign paroxysmal positional vertigo

BPPV is a rare presentation in children, which has been considered by some authors as related to the fact that, at this age, otoconia are firmly attached to the macula of the utricle.¹⁹ On the other hand, it is one of the most frequent causes of vertigo in adults. Even so, in our population, this has proven to be quite frequent. Treatment for BPPV involves repositioning manoeuvres.

Vestibular Neuritis

Although VN is rarely diagnosed, it is among the most frequent causes of rotational vertigo in the paediatric population,^{5,7,12} with a controversial aetiology that seems to be associated with a previous viral infection (most often an upper airway infection).¹ The presentation is similar to that of adults, both in terms of symptoms, with persistent rotational vertigo, difficulty in ambulation, nausea and vomiting, and regarding physical examination, with signs of acute vestibular hypofunction (with spontaneous nystagmus, HIT showing catch-up saccades and abnormal Romberg and UF tests).

Treatment is debatable and no gold-standard approach has been established^{5,9} and is usually based on systemic corticoid therapy and vestibular rehabilitation, as in the adult population; on the other hand, the role of antiviral drugs has not yet been established.^{1,5}

Compared with adults, the potential for recovery in the paediatric age is much more favourable.^{1,5,7}

Other causes

TBI were described in literature as a relatively frequent cause of instability or vertigo,⁹ with different pathophysiological mechanisms, although it may be related to temporal bone fracture, concussion of the labyrinth or occasionally to a perilymphatic fistula. One of our patients presented with BPPV after a severe TBI.

Ménière's disease is usually associated with episodes of rotational vertigo, fluctuating hearing loss, tinnitus and aural fullness.⁵ According to the consensus reached in 2015 by different medical societies aimed at the study of balance, a definitive diagnosis is established in the presence of at least two episodes with symptoms lasting 20 minutes to 12

Table 3 – Diagnostic criteria for vestibular migraine¹⁷

1. Vestibular migraine
<p>A. At least 5 episodes with vestibular symptoms of moderate or severe intensity, lasting 5 minutes to 72 hours</p> <p>B. Current or previous history of migraine with or without aura</p> <p>C. At least one migraine feature with at least 50% of the episodes:</p> <ul style="list-style-type: none"> - headache with at least two of the following characteristics: one sided location, pulsating quality, moderate or severe pain intensity, aggravation by routine physical activity - photophobia and phonophobia - visual aura <p>D. Not better accounted for by another vestibular or migraine diagnosis</p>
2. Probable vestibular migraine
<p>A. At least 5 episodes with vestibular symptoms of moderate or severe intensity, lasting 5 minutes to 72 hours</p> <p>B. Only one of the criteria B and C for vestibular migraine is fulfilled (migraine history of migraine features during the episode)</p> <p>C. Not better accounted for by another vestibular or migraine diagnosis</p>

hours (Table 4).²⁰ Although adult patients aged 30-50 are more affected by the disease, paediatric patients are also affected in rates of 1.5 to 4% in some series.¹

Finally, OME is considered in literature as the leading cause of vestibular symptoms in the paediatric age.^{1,2,5,10,18} It is usually not associated with vertigo *per se*, rather being described by parents as gait instability, 'clumsy' gait or frequent falls.¹ However, symptoms frequently resolve after myringotomy with tympanostomy tube insertion. In the series of 136 children with OME and vestibular symptoms evaluated by Golz *et al.*, there was a resolution of the signs of vestibular abnormality in 96% of the patients after tympanostomy tube insertion.²¹

CONCLUSION

The outcomes in vertigo outpatient clinic at HB were in line with those found in studies with similar methodologies. A careful history and physical examination may be all that is required to make a diagnosis and cochleovestibular tests and neuroimaging are of varying significance and should be considered on a case-by-case basis.

On the other hand, vestibular pathology affecting the paediatric population has assumed an increasing relevance and it is significantly more prevalent than what was considered in the past, according to the most recent literature, mainly due to the different forms of presentation. The recognition of the different signs and symptoms by those examining paediatric patients is crucial for an adequate referral, diagnosis and treatment. Our outcomes, even though in line with literature, show little variability in terms of reasons for referral, leading to the conclusion that a lack of awareness of VD in paediatric-age. Therefore, this may lead to sub-optimal diagnostic performance.

According to current literature, it is recommended the development of referral guidelines for vestibular assessment of patients diagnosed with syndromes frequently as-

sociated with VD and, on the other hand, of patients diagnosed with sensorineural hearing loss. Finally, the implementation of assessment protocols for these patients is required, namely through the inclusion of testing with greater diagnostic acuity that could overcome the implementation constraints and their interpretation at this age, in addition to the creation of multidisciplinary teams qualified for the treatment of these patients.

OBSERVATIONS

This study was presented to the round table discussion entitled "Vestibular testing in children" at the fifth Congress of the Confederation of European Otorhinolaryngology and Head and Neck Surgery, which was held in July 2019, in Brussels, Belgium.

HUMAN AND ANIMAL PROTECTION

The authors declare that this project complied with the regulations that were established by the Ethics and Clinical Research Committee, according to the 2013 update of the Helsinki Declaration of the World Medical Association.

DATA CONFIDENTIALITY

The authors declare that they have followed the protocols of their work centre on the publication of patient data.

CONFLICTS OF INTEREST

The authors declare that there were no conflicts of interest in writing this manuscript.

FINANCIAL SUPPORT

The authors declare that there was no public or private financial support in writing this manuscript.

Table 4 – Diagnostic criteria for Ménière's disease²⁰

1. Definite Ménière's disease
A. Two or more spontaneous episodes of vertigo, each lasting 20 minutes to 12 hours
B. Audiometrically documented low to medium frequency sensorineural hearing loss in one ear, defining the affected ear on at least one occasion before, during or after one of the episodes of vertigo
C. Fluctuating aural symptoms (hearing loss, tinnitus or fullness) in the affected ear
D. Not better accounted for by another vestibular diagnosis
2. Probable Ménière's disease
A. Two or more spontaneous episodes of vertigo, each lasting 20 minutes to 12 hours
B. Fluctuating aural symptoms (hearing loss, tinnitus or aural fullness) in the affected ear
C. Not better accounted for by another vestibular diagnosis

REFERENCES

1. Gioacchini FM, Alicandri-Ciuffelli M, Kaleci S, Magliulo G, Re M. Prevalence and diagnosis of vestibular disorders in children: a review. *Int J Pediatr Otorhinolaryngol.* 2014;78:718-24.
2. Dhondt C, Dhooge I, Maes L. Vestibular assessment in the pediatric population. *Laryngoscope.* 2019;129:490-3.
3. O'Reilly RC, Greywoode J, Morlet T, Miller F, Henley J, Church C, et al. Comprehensive vestibular and balance testing in the dizzy pediatric population. *Otolaryngol Head Neck Surg.* 2011;144:142-8.
4. Kuhn JJ, Lavender VH, Hunter LL, McGuire SE, Meinzen-Derr J, Keith RW, et al. Ocular vestibular evoked myogenic potentials: normative findings in children. *J Am Acad Audiol.* 2018;29:443-50.
5. Devaraja K. Vertigo in children; a narrative review of the various causes and their management. *Int J Pediatr Otorhinolaryngol.* 2018;111:32-8.
6. Szirmai A. Vestibular disorders in childhood and adolescents. *Eur Arch Oto-Rhino-Laryngol.* 2010;267:1801-4.
7. Gruber M, Cohen-Kerem R, Kaminer M, Shupak A. Vertigo in children and adolescents: characteristics and outcome. *Scientific World Journal.* 2012;2012:109624.
8. Erbek SH, Erbek SS, Yilmaz I, Topal O, Ozgirgin N, Ozluoglu LN, et al. Vertigo in childhood: a clinical experience. *Int J Pediatr Otorhinolaryngol.* 2006;70:1547-54.
9. Rine RM, Wiener-Vacher S. Evaluation and treatment of vestibular dysfunction in children. *Neuro Rehabilitation.* 2013;32:507-18.
10. Casani AP, Dallan I, Navari E, Sellari Franceschini S, Cerchiai N. Vertigo in childhood: proposal for a diagnostic algorithm based upon clinical experience. *Acta Otorhinolaryngol Ital.* 2015;35:180-5.
11. Martens S, Dhooge I, Dhondt C, Leyssens L, Sucaet M, Vanaudenaerde S, et al. Vestibular Infant Screening – Flanders: the implementation of a standard vestibular screening protocol for hearing-impaired children in Flanders. *Int J Pediatr Otorhinolaryngol.* 2019;120:196-201.
12. Janky KL, Rodriguez AI. Quantitative vestibular function testing in the pediatric population. *Semin Hear.* 2018;39:257-74.
13. Niemensivu R, Pyykkö I, Valanne L, Kentala E. Value of imaging studies in vertiginous children. *Int J Pediatr Otorhinolaryngol.* 2006;70:1639-44.
14. Wiener-Vacher SR. Vestibular disorders in children. *Int J Audiol.* 2008;47:578-83.
15. Niemensivu R, Pyykkö I, Kentala E. Vertigo and imbalance in children. *Arch Otolaryngol Neck Surg.* 2005;131:996.
16. O'Reilly RC, Morlet T, Nicholas BD, Josephson G, Horlbeck D, Lundy L, et al. Prevalence of vestibular and balance disorders in children. *Otol Neurotol.* 2010;31:1441-4.
17. Lempert T, Olesen J, Furman J, Waterston J, Seemungal B, Carey J, et al. Vestibular migraine: diagnostic criteria. *J Vestib Res.* 2012;22:167-72.
18. Davitt M, Delvecchio MT, Aronoff SC. The differential diagnosis of vertigo in children. *Pediatr Emerg Care.* 2017;00:1.
19. Baloh RW, Honrubia V. Childhood onset of benign positional vertigo. *Neurology.* 1998;50:1494-6.
20. Lopez-Escamez JA, Carey J, Chung WH, Goebel JA, Magnusson M, Mandalà M, et al. Diagnostic criteria for Menière's disease. *J Vestib Res Equilib Orientat.* 2015;25:1-7.
21. Golz A, Netzer A, Angel-Yeger B, Westerman ST, Gilbert LM, Joachims HZ. Effects of middle ear effusion on the vestibular system in children. *Otolaryngol Head Neck Surg.* 1998;119:695-9.