0021-7557/03/79-04/337
Jornal de Pediatria

ORIGINAL ARTICLE

Evaluation of the treatment of vestibular disorders in children with computerized dynamic posturography: preliminary results

Ítalo R.T. Medeiros,[1] Roseli S.M. Bittar,[2] Maria Elisabete B. Pedalini,[3] Maria Cecília Lorenzi,[4] Márcia A. Kii,[1] Lázaro G. Formigoni[5]

Abstract

Objective: this study aimed at evaluating dynamic posturography as an evaluation method in children with balance problems due to peripheral vestibulopathy, before and after treatment with vestibular rehabilitation, establishing its correlation with classical clinical evaluation.

Method: ten children (six boys and four girls) with vestibular symptoms of peripheral origin were evaluated through a complete clinical history and with dynamic computerized posturography after being treated by vestibular rehabilitation therapy. Posturographic data were analyzed and compared to standard clinical evaluation parameters.

Results: dynamic posturography showed a significant improvement of condition 1 (orthostatic position, fixed support and open eyes) and 5 (orthostatic position, sway-referenced support and closed eyes) of the vestibular function and of the composite balance score. The data showed significant correlation with the clinical improvement observed. A significant reduction of proprioceptive influence was also observed.

Conclusion: data showed that the dynamic posturography adds important quantitative information to the conventional clinical evaluation of vestibular symptoms, especially in children.

J Pediatr (Rio J) 2003;79(4):337-42: child, dizziness, vestibular diseases, vestibular function tests, rehabilitation.

Introduction

Dizziness is a symptom that is often forgotten or undervalued when anamnesis is performed with children. This complaint can be associated with many other conditions, often different to those found in adults. It is as a result of this difficulty that pediatricians, neurologists and even otorhinolaryngologists are not alert to childhood vestibular disorders.

The social and emotional repercussions of these complaints within this age group (childhood) are much

1. PhD. Assistant physician, Otoneurology Division, Hospital das Clínicas, School of Medicine, Universidade de São Paulo.
2. PhD. MD, Otoneurology Division, Hospital das Clínicas, School of Medicine, Universidade de São Paulo.
3. Speech Therapist, Outpatient Clinic of Vestibular Rehabilitation, School of Medicine, Universidade de São Paulo. Graduate student, School of Medicine, Universidade de São Paulo.
4. PhD.
5. PhD. Assistant physician, Otoneurology Division, Hospital das Clínicas, School of Medicine, Universidade de São Paulo.
6. Associate Professor, School of Medicine, Universidade de São Paulo.

Financially supported by: FAPESP.

Manuscript received Nov 18 2002, accepted for publication Mar 12 2003.

more harmful than they are with adults.[1] The emotional distancing or isolation (introspection), educational disturbances, alterations to sleep patterns and phobias result in significant compromise to development. Situations involving movement emphasize the insecurity generated by vestibulopathy, to the extent that normal childhood activities such as riding a bicycle, playing in the park and joining-in with children's games and sports come to be avoided.[2]

Once a child has been diagnosed with vestibulopathy the most appropriate form of treatment should be embarked upon. Behavior varies from a "wait-and-see" approach, in milder cases with no clinical or social repercussions to the use of labyrinthine sedative drugs.[2] The medications used with children are basically the same ones used with adults and bring with them the corresponding side effects. With children we have been employing corporal equilibrium treatment with success by means of vestibular rehabilitation.[3]

The main problem which is encountered when dealing with this age group is difficulty in objectively quantifying symptoms. In the majority of cases, small patients have difficulty describing their complaints and it is generally their guardians who are the true sources of information, providing the most important facts for anamnesis. The same happens when the response to treatment is described. In this context Computerized Dynamic Posturography (CDP) appears to be a useful tool for quantifying this symptomology before and after treatment, whatever treatment may be proposed.[4]

CDP is an examination used for general assessment of balance which integrates labyrinthine, visual and somatosensory data. The most commonly used test is the Sensory Organization Test (SOT), which is made up of six sensory conditions the responses to which are registered by means of a moving platform (somatosensory data), the presence or absence of vision (visual data) and vestibular calibration.

Given the subjectivity of clinical assessments in cases of childhood vestibulopathy and the development of CDP as an examination which makes it possible to quantify the conditions involved in balance, this study was conceived with the main objective of analyzing posturographic data before and after the vestibular rehabilitation treatment of children with vestibulopathy, comparing these results with clinical data and defining the role of this new diagnostic option in these cases.

Material and Methods

Ten children were assessed, prospectively in an observational study. They had been treated consecutively at the Childhood Vertigo Clinic at the Hospital das Clínicas at FMUSP (HCFMUSP), for complaints of dizziness, associated or not with headaches, and were referred by the neuropediatrics or general otorhinolaryngology clinics of the same hospital.

Exclusion criteria were: the presence of functional alterations to the middle ear, degenerative neurological conditions and vestibular problems whose origin was metabolic.

After authorization by the Commission for Ethics in Research of HCFMUSP, the children's parents or guardians were requested to sign an Informed Consent Form after explanations had been given and they had agreed to the child's participation (protocol HC - 187/98). The children then underwent detailed anamnesis (passive and active) together with their accompanying adults. A diagnosis of vestibulopathy was defined by means of an electronystagmographic examination, and a rotary chair test used to reinforce the diagnosis in some cases. A complete hearing assessment was also performed in order to rule out conditions of the middle ear, the presence of which was a criterion for exclusion.

Further to the neurological assessment, the following were performed for all children: metabolic examinations (fasting glycemia, total cholesterol and its fractions, triglycerides and thyroid hormones) and also a syphilis serum test. The presence of alterations in any of these tests also meant that the child was excluded from the protocol.

Next, the children with vestibulopathy were subjected to CDP with Equitest System™ - Version 4.0 equipment, produced by NeuroCom International™- USA.

In conventional posturography (Equitest™) six conditions are assessed as part of the Sensory Organization Test:

Condition 1: Patient in an orthostatic position, platform fixed and eyes open.

Condition 2: Patient in an orthostatic position, platform fixed and eyes closed (classic *Romberg* test).

Condition 3: Patient in an orthostatic position, platform fixed, eyes open and vision sway referenced.

Condition 4: Patient in an orthostatic position, platform moving and eyes open.

Condition 5: Patient in an orthostatic position, platform moving and eyes closed.

Condition 6: Patient in an orthostatic position, platform and vision moving, eyes open.

The objective under each of these conditions is to maintain static equilibrium. The patient is instructed to remain as immobile as possible on the platform, even when the platform and the visual field oscillate. Results are quantified from 100% (no dislocation whatsoever was registered by the platform's sensors) to 0%, which corresponds to a fall in any direction. Based on the data recorded under each of these conditions, *Equitest*™ is capable of calculating the average for each of them, an index for somatosensory, visual and vestibular functions and the relationship between visual and vestibular information, known as *visual preference*, in addition to a balance index, all of which are described below:

Somatosensory function: Average of condition 2 / Average of condition 1.

Visual function: Average of condition 4 / Average of condition 1.

Vestibular function: Average of condition 5 / Average of condition 1.

Visual preference: Average of condition 3 + 6 / Average of condition 2 + 5.

Equilibrium score: Arithmetic average of the three repetitions of conditions 1 and 2 and of the two best results under conditions 3, 4, 5 and 6.

Once the first posturography session had been performed for each of the children to be studied, the vestibular rehabilitation (VR) program was begun. This was done with the help of family members and consisted of training and exercise sessions based on the techniques described by Cawthorne & Cooksey, modified and adapted for our population.[5] The exercises performed are based on a series of repeated movements of the head, neck and eyes which are intended to stimulate the labyrinthine compensation process. None of the children, even the smallest, needed us to adapt the exercises from those used with adults. Four follow-up sessions were held (1st, 15th, 30th and 60th days).[3,6] After vestibular rehabilitation therapy, always performed by the same phonoaudiologist, the patients were examined once more by CDP.

The analysis methodology included descriptive and non-parametric statistical tools. Clinical assessment of the therapeutic response of VR used the number of symptoms before and after treatment and their variation as analysis variables. Additionally, cure, improvement or unaltered status after treatment were noted. The presence of kinetosis was also observed.

The Wilcoxon test was employed to evaluate the different results from before and after treatment. The percentage improvement under condition nº 5 (five) was calculated as follows: **[(final value - initial value) ÷ initial value] x 100**.

The correlation between subjective clinical evaluation and the results of CDP evaluation (percentage of improvement under condition 5) was studied using the *Spearman* test.

The level of at which results were considered significant was 0.05, as approved for biological experimentation ($p < 0.05$).

Results

Six of the ten patients assessed were male and four were female. Ages varied from 5.4 years to 10.3 years (mean = 8.3 ± 1.6 years).

Clinical assessment of the results of treatment

The information obtained on the ten patients studied can be observed in Table 1.

All of the patients referred to dizziness during anamnesis. Other frequent clinical symptoms included headaches (80%), nausea and vomiting (70%), problems playing (60%) and kinetosis (50%) of cases. In addition, abdominal pains, tendencies to fall over (in 20% of cases), pallor and head deviation (in 10% of cases).

A general summary of the number of symptoms before and after treatment and descriptions of the clinical evolution in each case can be found in Table 2. The kinetosis described by some of the children presented clinical improvements with reductions in intensity, without however achieving

Table 1 - Symptoms observed in ten children studied

	Dizziness	Headaches	Kinetosis	Nausea and vomiting	Pallor	Abdominal pain	Problems playing	Tendencies to fall over	Sleep disorder	Head deviation
Patient 1	+	+	+	+	+	+	+			
Patient 2	+	+				+	+	+	+	
Patient 3	+	+					+			+
Patient 4	+	+		+			+			
Patient 5	+	+								
Patient 6	+		+	+			+			
Patient 7	+	+		+			+			
Patient 8	+	+	+	+				+		
Patient 9	+	+	+	+						
Patient 10	+		+	+						
Total	10	8	5	7	1	2	6	2	1	1

total remission. We also observe that there were no cases in which clinical status was unaltered after treatment (40% improvement and 60% remission of clinical symptoms).

CDP assessment of the same patients

The comparison of average results under each of the various dynamic posturography conditions studied, before and after treatment, can be found in Table 3.

We observed a significant increase in the numerical values produced under conditions 1 and 5. Condition 1 is in an orthostatic position with eyes open and condition 5 is in an orthostatic position with eyes closed and the platform in motion. This last is the best condition under which to evaluate the vestibular system, since visual and proprioceptive information is excluded. We also observed a significant reduction in somatosensory and adjacent function under condition 2.

The average percentage improvement under condition 5 was 29.0%.

Study of the correlation between clinical assessment and CDP evaluation

The correlation between clinical assessment before and after treatment (measured by the variation in the number of symptoms before and after treatment - the 4th column in Table 2) and the variation in vestibular performance (measured by the percentage improvement under condition 5) is moderate and negative (r = - 0.50), showing that the more significant the reduction in number of symptoms, the better the post-treatment vestibular performance and the higher the value returned under condition 5.

Studying the group of patients who had a remission of symptoms (n = 6) separately from those who presented partial improvement, maintaining a mild degree of kinetosis after treatment (n = 4), we did not observe any significant different between initial condition 5 values for the two groups (similar initial vestibular performance). Neither was there any difference in terms of the percentage of vestibular performance improvement between the two groups of patients, although we did observe a tendency towards greater performance gain among those patients who presented a final remission of symptoms (Figure 1).

Discussion

Hubbell & Skoner,[7] in their revision of vertigo in childhood, cite posturography as a diagnostic method for dizziness during childhood, but do not go into the subject to any depth. The lack of data on posturography with children was emphasized by the consensus document on vestibular system diagnostic methods released by the American Academy of Neurology.[4]

Rine et al.,[8] Hirabayashi & Iwasaki[9] and Shimizu et al.[10] define normality standards for dynamic posturography with children, taking weight and age into consideration. The first two authors studied children from three years of age upwards for their standardizing study and concluded that the somatosensory system is the first to reach maturity, which happens at around three to four years of age. Visual and vestibular systems mature later.

There are innumerable works which discuss rehabilitation in adults.[11-14] This type of therapy can also be used for children,[15] although a large proportion of the difficulty

Table 2 - Variation in the number of symptoms after treatment with VR and clinical evolution of the children studied

Patient	n of initial symptoms	n of symptoms after treatment	Symptoms variation	Clinical evolution	Kinetosis before treatment	Kinetosis after treatment
1	7	0	- 7	remission	+	-
2	6	0	- 6	remission	-	-
3	4	0	- 4	remission	-	-
4	4	0	- 4	remission	-	-
5	2	0	- 2	remission	-	-
6	4	1	- 3	improvement	++	+
7	4	0	- 4	remission	-	-
8	5	1	- 4	improvement	++	+
9	4	1	- 3	improvement	++	+
10	3	1	- 2	improvement	++	+

Table 3 - Numerical means of several conditions before and after VR treatment

	Mean before treatment (± SD)	Mean after treatment (± SD)	Statistical analysis	
Condition 1	89.7 ± 3.3	91.8 ± 2.6	Significant increase	(p = 0.01)
Condition 2	89.0 ± 2.8	87.9 ± 3.3	Significant reduction	(p = 0.05)
Condition 3	88.3 ± 4.5	88.7 ± 4.0	Significant increase	(p = 0.05)
Condition 4	69.0 ± 7.9	73.9 ± 10.2	Nonsignificant increase	(p = 0.05)
Condition 5	47.7 ± 11.8	59.5 ± 10.0	Significant increase	(p = 0.01)
Condition 6	51.0 ± 15.6	56.4 ± 6.5	Nonsignificant increase	(p = 0.05)
Somatosensory	99.3 ± 2.5	95.8 ± 2.5	Significant reduction	(p = 0.01)
Visual system	77.0 ± 9.5	80.4 ± 9.7	Nonsignificant increase	(p = 0.05)
Vestibular system	53.0 ± 12.3	64.6 ± 9.8	Significant increase	(p = 0.01)
Balance index	67.3 ± 6.2	72.5 ± 5.7	Significant increase	(p = 0.05)

SD = standard deviation.

involved in finding data within extant literature results from the fact that there is no quantative analysis proving the clinical improvements. For this reason we decided to use CDP for this analysis.

Posturography makes it possible to precisely quantify facts that are observed clinically. Clinical improvement is easily discerned by the therapist, otorhinolaryngologists and by the children's family members. Children with vestibulopathy in general have difficulty in expressing their symptoms in words, and often the conduct and assessment of therapy are prejudiced by this. Nevertheless, the child's disposition is visible when they play and the improvement of crises, whether measured in frequency or intensity, is easily observed.

When analyzing posturography, what stands out is that the significant improvements observed in final balance (equilibrium score) are primarily due to significant improvements under conditions 1 and 5. This data is compatible with that found in relation to VR with adults.[12,13] The improvement in sensory analysis of final vestibular function was also significant, further indicating objective and effective improvement under condition 5.

In contrast, another fact relevant to the assessment was the significant reduction in final somatosensory analysis results, which suggests a possible reduction in compensatory substitution of balance centers which would potentialize somatosensory input.

The excellent clinical evolution presented by the children who underwent vestibular rehabilitation is similar to that found in the literature[3] and corroborates the idea of the use of this therapy as a safe and effective method for the treatment of vestibular complaints during childhood.

The correlation between clinical improvement and improved CDP scores was found to exist with our patients. This permits us to suggest that posturography can assist clinical deduction in directing conduct of children who complain of dizziness secondary to vestibulopathy.

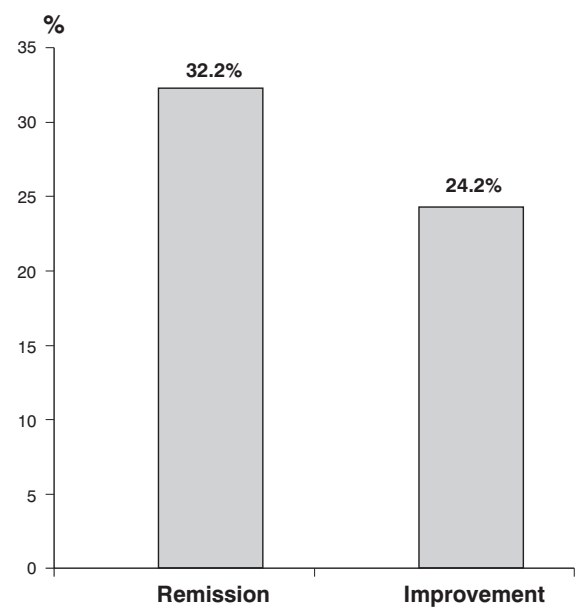

Figure 1 - Percentage of vestibular performance improvement (condition 5) among patients who present remission of symptoms after the treatment (n = 6) and patients who presented partial improvement (n = 4)

The children with kinetosis presented a clinical course which was different to that followed by the remainder of the patients. These patients, despite significant attenuation of this symptom, did not become completely asymptomatic. This reinforces the idea that assessment using qualitative clinical information retains its own indispensable qualities.

Studies of a larger number of patients from this age group could provide, with greater surety, further technical basis for confirming the importance of posturography in the assessment of children with vestibulopathy.

Conclusions

Although CDP is no substitute for conventional clinical evaluation, it provides significant quantative data which can be used for vestibular assessment of children, before and after treatment.

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Corresponding author:
Ítalo Roberto Torres de Medeiros.
Av. Dr. Arnaldo, 1927
CEP 01255-000 – São Paulo, SP, Brazil
E-mail: italomedeiros@uol.com.br