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Clinical experience with video Head Impulse Test in children

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ABSTRACT

Background: A standardized diagnostic protocol for children's vestibular assessment is still missing in daily clinical life. As rotatory chair testing and caloric test are usually not tolerated well by children, the aim of our study was not only to evaluate the importance and practicability of the video head impulse test performed in children with and without balance problems, but also to outline a diagnostic algorithm for children with balance problems.

Methods: Fifty-five children aged 3–16 years have been included in this prospective monocentric study. Balance was assessed using results from health screening examinations of the participants and results from a specific dizziness questionnaire for children. The children were then divided in two groups: group I without any sign of vestibular development disorder and group II with possible signs for a pathological equilibrium development. Horizontal vestibulo-ocular reflex (HVOR) was assessed using a video-oculography system device (EyeSeeCam©). Gain at 40, 60, and 80 ms and gain variance has been measured. Furthermore, it was evaluated how calibration of the system was tolerated by the participants, how the test itself was accomplishable in children, and which difficulties arose during testing.

Results: Reproducible test results were accomplished in 42 children (75%). Children with no balance problems in history showed a median gain of 1.02 ($\pm$0.28). A significant gain reduction between 40 and 80 ms was found ($P < 0.05$). Catch-up saccades were found in none of the children. Children with balance problems had a significantly reduced gain. (0.47 ± 0.3; $P < 0.05$) In this group, catch-up saccades could be detected in 4 out of 6 patients. For both groups, performing the test approximately took 20 min, which is significantly longer than in adults ($P < 0.05$). Calibration of the system with laser dots was easily doable in children aged 6 and older, whereas children between 3 and 5 years had better calibration results using colorful little icons.

Conclusions: Video head impulse test is a sensitive and efficient vestibular test in children, which is tolerated well by children aged 3–16 years. Therefore, video head impulse test can be easily used as a screening tool to detect vestibular dysfunction in the pediatric population.

1. Introduction

A standardized diagnostic protocol for children's vestibular assessment is still missing in daily clinical life—a problem, which has been recently described by Gioacchini and colleagues [1]. As classic vestibular tests like rotatory chair testing or caloric test are usually not tolerated well by children, more importance has to be paid on new neurotologic methods performed in children like the video head impulse test (vHIT). vHIT is a well-established device in adults, which measures the gain of the angular vestibular-ocular reflex (aVOR) during head rotations as the ratio of eye to head acceleration [2,3].vHIT evaluates the high frequency range of the VOR and can be seen as an advancement of the clinical head impulse test, which has been described by Halmagy and Curthoys in 1988 [4]. Today, videooculography systems for evaluating VOR are well-established tools in daily clinical life of neurologists and otolaryngologists, which easily, quickly, and cost efficiently measure semicircular function in adults.

As vestibular disorders and imbalance in children are recently described more often [5,6] sensitive and well-tolerated vestibular tests are urgently needed. Therefore, the aim of our study was to assess the importance and feasibility of the video head impulse test performed in children with and without balance problems, especially as pediatric normative data for the vHIT is not available yet.

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2. Material and methods

Written informed consent was obtained from all of the holder of parental responsibility of the tested children. The study was conducted in conformity with the Declaration of Helsinki 1975, revised 1983, and approved by the ethics committee of the University Medicine Mannheim, Germany.

2.1. Patients and study design

55 children (32 boys and 23 girls) aged 3–16 years have been included in this prospective monocentric study and have been tested between January 2013 and January 2014. None of the children had been diagnosed with a vestibular disorder before and all patients had normal vision. Otoscopic examination was performed prior to vHIT testing. Afterwards, clinical head impulse test was accomplished to explain the test procedure to the participants and their parents as well. Then vHIT was performed in the horizontal plane using a video-oculography system device (EyeSeeCam©). Additionally, the time needed to perform the test was measured in minutes. All 55 children were tested by either of two examiners who are at least 5 years experienced in clinical vestibular testings. Possible problems that occurred during testing of the children were noted. After completion of vHIT, balance was assessed using the results from health screening examinations of the participating children and results from a specific dizziness questionnaire for children. This information was collected after the vHIT to avoid examiners' bias. Those tests were considered to be pathologic if motoric development milestones were not achieved in time, if health screening examinations were pathologic or if the dizziness questionnaire was pathologic. For statistical analysis, the children were divided into two groups depending on the results of medical history and motoric developmental tests.

2.2. vHIT

Horizontal VOR (HVOR) was measured using a portable lightweight VOG device (EyeSee Cam™ system Interacoustics A/S Denmark™) that consists of a high speed infrared camera (sampling rate of 250 Hz) and a built-in accelerometer. vHIT was performed with the child in a seated position in room light. Calibration was performed with the integrated laser dots projected on the wall or if the child was too young or too agitated to follow the red laser dots precisely, with pictograms of animals stuck to the wall. After successful calibration, the child fixated a far target (distance approximately 1.5 m), in the recent study an animal pictogram. Target head velocity was 100–200 degrees per second with amplitude between 5 and 15 degrees from center to lateral. The impulses were unpredictable with respect to both directions (right versus left). At least 10 impulses were performed for each site. Whenever needed, the child was given a break after an impulse to resume concentration. In total, at least 15 impulses to each side were obtained. VOR gain was calculated as the ratio of eye to head velocity at 40, 60, and 80 ms. Furthermore, gain variance was assessed. The appearance of "covert" and "overt" saccades was additionally analyzed. A compensatory saccade was classified as a "covert" saccade when it occurred during the head movement [7]. If the saccade occurred after the head velocity crossed zero, it was considered to be "overt" (Figs. 1 and 2).

A paired one-sided *t*-test was performed to analyze the differences in gain between 40, 60, and 80 ms. A paired one-sided *t*-test was performed to compare gains of children with and without balance problem. Descriptive statistics were used to measure VOR gains, time of examination, and gain variance. For all statistical analyses, associations were considered statistically significant with a value of $P < 0.05$. Statistical analysis was performed using SPSS Statistics 17.0 (SPSS Inc., Chicago, IL).

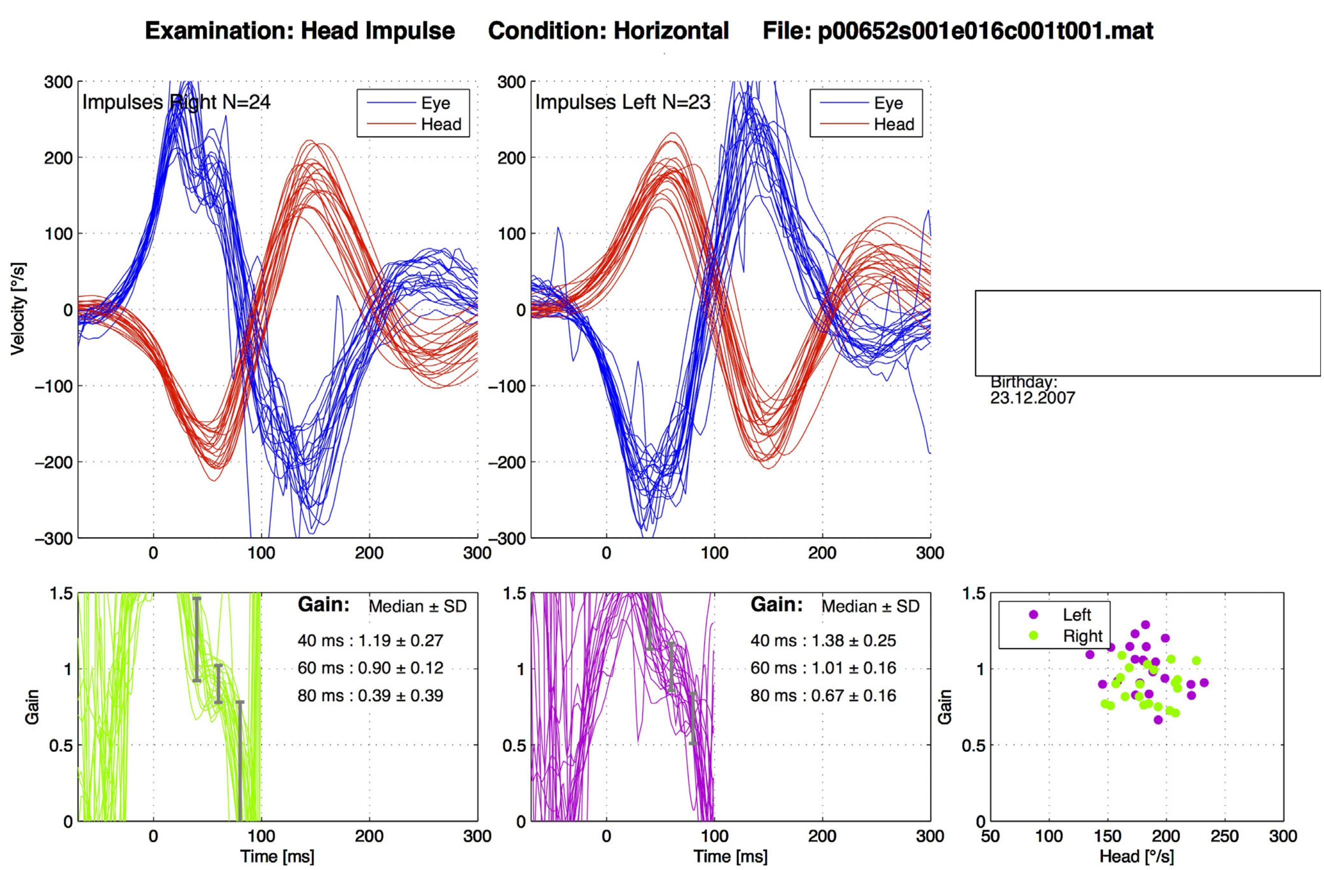

Fig. 1. A normal vHIT of a 6-year-old boy is shown above.