THE FUNCTIONAL HEAD IMPULSE TEST (fHIT)

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Introduction

- It evaluates the functional status of the rotational vestibulo-ocular reflex (rVOR) of the six semicircular canals at high frequencies of vestibular stimulation.

- If the semicircular canals are defective, the rVOR is jeopardized.
How to evaluate semicircular canals?

- Caloric test VNG/ENG,
- Dynamic Visual Acuity (DVA) test
- Gaze Stabilization Test (GST)
- Video Head Impulse Test (VHIT)
Comparison with other tests

- In VHIT the degradation of visual acuity is not calculated but the gain of the VOR is calculated.
- In DVA degradation of the Visual Acuity (VA) on fast head movement is measured and if the loss of VA is more than 0.2 logMAR (the unit by which VA is measured) then the VOR is considered subnormal indicating a poor semicircular canal function.
In VHIT, the impairment of VOR gain (not the loss of VA) on fast head movement is calculated.

VHIT measures the gain of the VOR generated by the head movement.

It requires to measure speed of both head and eye movement.

Since, head movement measurement is technically easy with gyroscopes and accelerometers but, measurement of eye movement is technically difficult and requires sophisticated high speed cameras and very complex computation.

This makes VHIT a costly gadget that many practitioners find difficult to afford.
Comparison with other tests

- FHIT does not calculate the quantity of the loss of Visual Acuity in logMAR as in DVA which requires testing VA with gradually smaller size of optotypes.

- This process requires quite a bit of time and increases the complexity of the test; fHIT just determines whether there is any loss of readability of a pre-determined fixed size optotype on sudden head movement.
Comparison with other tests

- fHIT objectively documents the performance of the patient’s VOR in real life practical situation and is tested with a physiological stimulus (i.e., fast head movement which we always do in our day to day lives) unlike the un-physiological stimulus (hot & cold stimulation) used in the caloric test.
Why do we need fHIT??

- Functional test
- Quick & easy to do
- Does not require costly equipment set up
- Qualitative approach
- Results obtained are easily interpreted
fHIT Hardware:
fHIT place the sensor on the patient's forehead

The 3 axis gyroscope and an accelerometer housed in a small box attached to the elastic headband that the patient wears
The patient response unit

This calculator shaped device has the eight types of Landolt ‘C’ s which are the replicas of the optotypes that appear on the computer screen. The patient has to press the key that corresponds to the optotype appearing on the screen.
fHIT place the patient 1.5 meters from the screen
fHIT an easy test. Start, Open, Close.
fHIT Age, Sex, Visual acuity

fHIT require only a few data of the patient: sex, age and visual acuity.
The software finds the max visual acuity of the patient and grows the optotype of 0.6 Log to do fHIT test.
fHIT Functional Head Impulse test

You can choose to do RALP, LARP or LATERAL test.
Functional Head Impulse test

The sensor must be placed on the patient's forehead. It must be well fixed and it must not move during the test.

The doctor have to keep his hands on the patient's cheeks, without touching the elastic band of the sensor.
The patient has to identify the optotypes correctly and press the identical key in the hand held device.

The patient responds by pressing the identical key in the hand held device.
The test for the Right anterior and left posterior canals (RALP) being done. The operator stands behind the patient and rotates the head vertically in the plane of the right anterior and left posterior canals at a high speed.
The fHIT for the left anterior and right posterior canals (LARP) being done.
While the test is being done, the operator can constantly monitor the acceleration and velocity graphically as well as the number of times the test has been done at each range (acceleration bin). The movement highlighted in yellow is the last movement made.

In the above figure, the yellow marked one is a test for the left posterior canal. The left sided tests are marked in blue and the tests on the right canals (lateral / anterior/ posterior) in red.
The results and Interpretation
Interpretation

Number of impulses for acceleration bin

% of correct answers for acceleration bin

In green are reported normality thresholds

Total % of correct answers and normality thresholds in parenthesis
Functional Head Impulse Test

Outcome = percentage of reading

Patient

\[ Z = \text{Healthy} \]
\[ Z^* = \text{Deficit} \]
\[ Z^{**} = \text{Deficit} \]

Z indicate the statistical comparison of patient responses with the group of normal subjects.
Healthy Patient:

CCW (Left)
- Tot Movimenti: 17/30
- Risposte OK: 94,1% [89,6%]

CW (Right)
- Tot Movimenti: 18/30
- Risposte OK: 100,0% [92,9%]

Vestibologramma CCW (Left)

Vestibologramma CW (Right)

Contatore Movimenti CCW (Left)

Contatore Movimenti CW (Right)

Diagnosi CCW: Z = -0.417

Diagnosi CW: Z = -1.258

Diagnosi CW: Z = -1.350
B/L Canal Deficit patient:

CCW (Left)
- Total Movimenti: 30/30
- Risposte OK: 76.7% [94.3%]

CW (Right)
- Total Movimenti: 30/30
- Risposte OK: 60.0% [95.3%]

Vestibilitogramma CCW (Left)

Vestibilitogramma CW (Right)

Contatore Movimenti CCW (Left)

Contatore Movimenti CW (Right)

Diagnosi CCW: **Z = 3.558
Diagnosi: **Z = 5.798
Diagnosi CW: **Z = 6.102
LEFT ACUTE VESTIBULAR NEURITIS

Data referto: 15/05/2017
Operatore referto: utente utente

Impulso della testa

\[ \hat{x} \text{ Sinistra: } 0.33, \sigma: 0.1 \]
\[ \hat{x} \text{ Destra: } 0.73, \sigma: 0.07 \]

Asimmetria relativa: 55%

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CCW (Left)
Tot Movement: 10/30
Answers OK: 30,0% [93,3%]

Vestibologramma CCW (Left)

Movement Counter CCW (Left)

Diagnosis CCW: \( **Z = 7.624 \)

CW (Right)
Tot Movement: 10/30
Answers OK: 80,0% [94,0%]

Vestibologramma CW (Right)

Movement Counter CW (Right)

Diagnosis CW: \( Z = 1.726 \)
LEFT ACUTE VESTIBULOPATHY (FOLLOW-UP 3 MONTHS)
LEFT VESTIBULAR NEURITIS 6 MONTHS FOLLOW-UP (RECOVERY)

Data referto: 15/05/2017

Prova impulso laterale: 05/04/2017 11:26:03

Operatore della prova: utente utente

Impulso della testa

Asimmetria relativa: 7%

Velocità di occhio e testa

-100 0 100 200 300

Lateral sinistra (LS) ms

Guadagni medi: 0,84

Velocità di occhio e testa

-100 0 140 280 420 560

Lateral destra (LD) ms

Guadagni medi: 0,9

CCW (Left)

Tot Movement: 10/30

Answers OK: 100,0% [93,3%]

Diagnosis CCW: Z = -0,823

CW (Right)

Tot Movement: 10/30

Answers OK: 100,0% [94,0%]

Diagnosis CW: Z = -0,823
Conclusion:

- fHIT is hence a very useful addition to the neurotologist’s diagnostic armamentarium and a boon to the clinician in many ways.
- We have been using the system in our clinic for the last 18 mths and it has been a fascinating experience.
Introduction

- fHIT is not only a diagnostic device but also a therapeutic device where specific targeted physical therapy to stimulate the diseased canal is possible.

- Modern vestibular physiotherapy entails specific organ targeted exercises for specific disorders after modern vestibulometry has very precisely diagnosed the disorder.

- V-Gym is a device for rehabilitative process of targeted canal disorder.
V gym Principle
The Hardware & Set up

- The v Gym device consists of:
  - A sensor mounted on an elastic band
    - provided with an accelerometer and a gyroscope,
    - connected via Bluetooth to a smartphone or tablet device
  - An app developed by Beon Solutions.

- The patient wears the sensor as shown in the picture on the right

  The tool allows to perform the exercise in different conditions:
  - sitting;
  - standing;
  - walking.
The Application - Working

Main functions

1. User sign in
   Set Patient ID
2. Set rehabilitation program
3. Set exercise duration
4. Start!

Other functions

- Access to setting screen
- Sensor reset
- Exit from app
The patient moves the head fixing the point in the screen.

If the movement is too narrow the software suggests to move the head more widely.

If the movement is too fast the software suggests to move the head slower.

If the movement is correct a number or a letter will appear.
In the end of the time’s exercise appear a summary of exercise parameters:

- Effective duration
- Number of movements performed
- Percentage of correct answers
- Saving of session data
V Gym
# V Gym - Rehabilitation programs

<table>
<thead>
<tr>
<th>Program</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single N1, N2, N3</td>
<td>Single movement, narrow angle (15°)</td>
</tr>
<tr>
<td>Single W1, W2, W3</td>
<td>Single movement, wide angle (30°)</td>
</tr>
<tr>
<td>Multi N1, N2, N3</td>
<td>Multiple movement, narrow angle (15°)</td>
</tr>
<tr>
<td>Multi W1, W2, W3</td>
<td>Multiple movement, wide angle (30°)</td>
</tr>
<tr>
<td>Sport 1, 2, 3</td>
<td>Targeted at healthy subjects</td>
</tr>
</tbody>
</table>
fHIT Rehab
Conclusion

- This new device is a boon to neurotologists because of its very simple mechanism which practically does not ever go out of order due to its extremely simple technology, its affordability and of course its very precise diagnostic and therapeutic functions.