INTEREST OF VESTIBULAR EVALUATION IN SEQUENTIALLY IMPLANTED CHILDREN: PRELIMINARY RESULTS

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VESTIBULAR EVALUATION IN SEQUENTIALLY IMPLANTED CHILDREN: *INTRODUCTION*

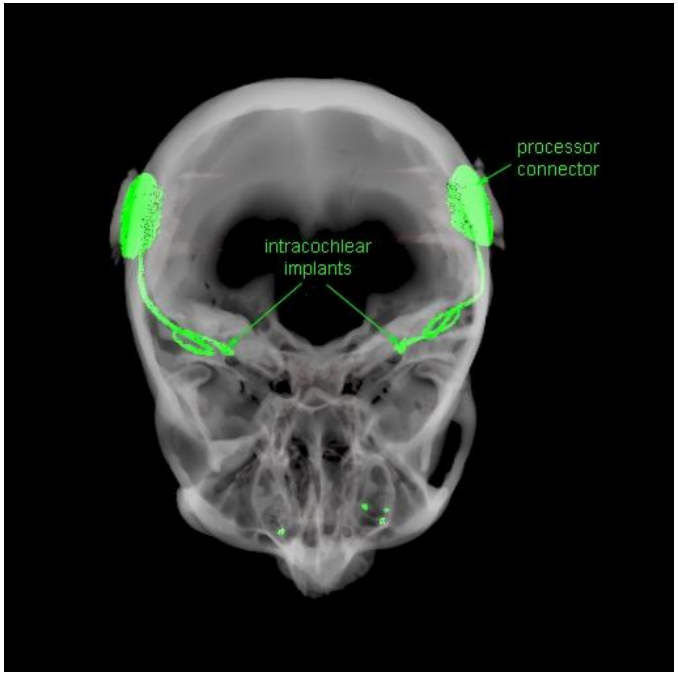
- Many children with **profound sensorineural hearing loss** also display **vestibular disorders** (20 – 85%)
- At present there is evidence supporting:
  - The additional benefit of having bilateral cochlear implantation in deaf children
  - a high probability of postoperative vestibular modifications

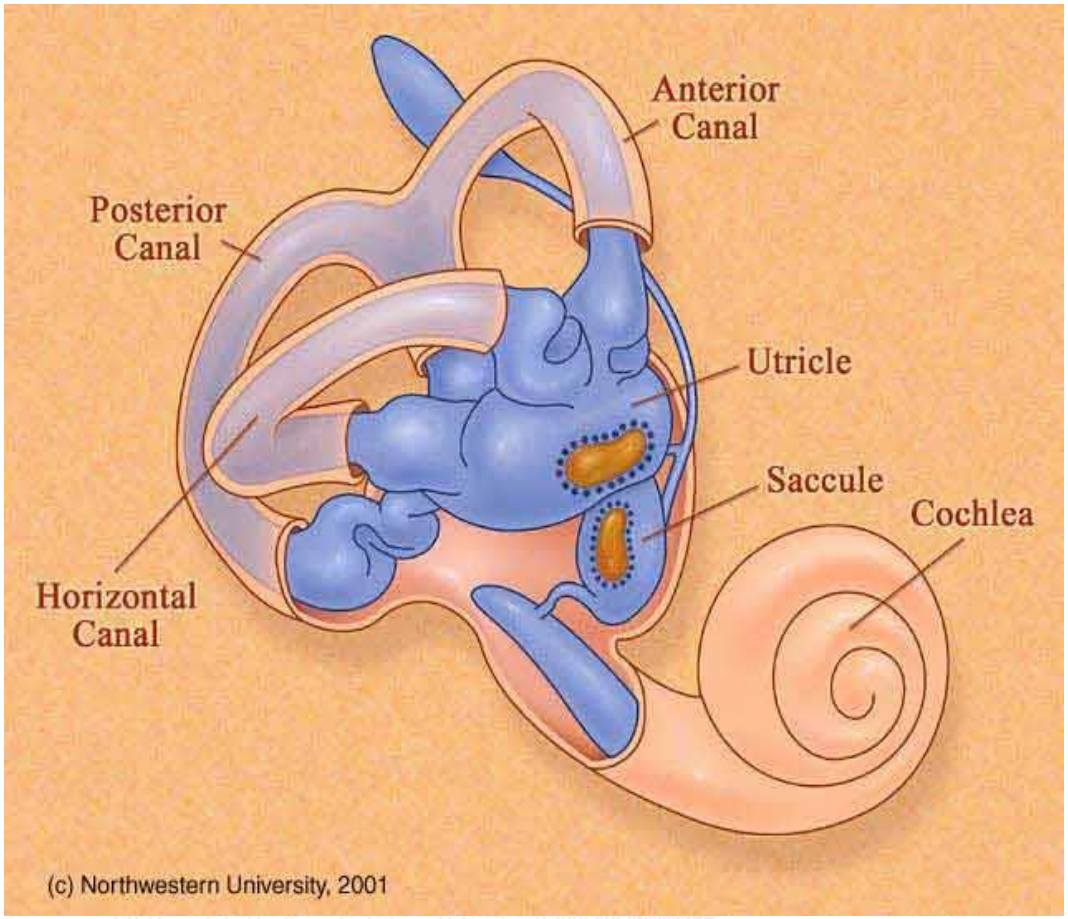
    Vestibular modifications in 50% of the cases with 10% of complete vestibular loss after CI

Cushing et al, 2008; Abramides et al, 2009; De Kegel et al, 2012
Wiener-Vacher et al, 2008

ADDITIONAL BENEFIT OF BILATERAL IMPLANTATION IN CHILDREN

- Better sound localization
- Better speech perception in noise
- Better quality of life





Labyrinth

- Cochlea
- Vestibule
  - → saccule
  - → utricle

  } Otolith organs
- Semi-circular canals

Vestibular receptors (5)

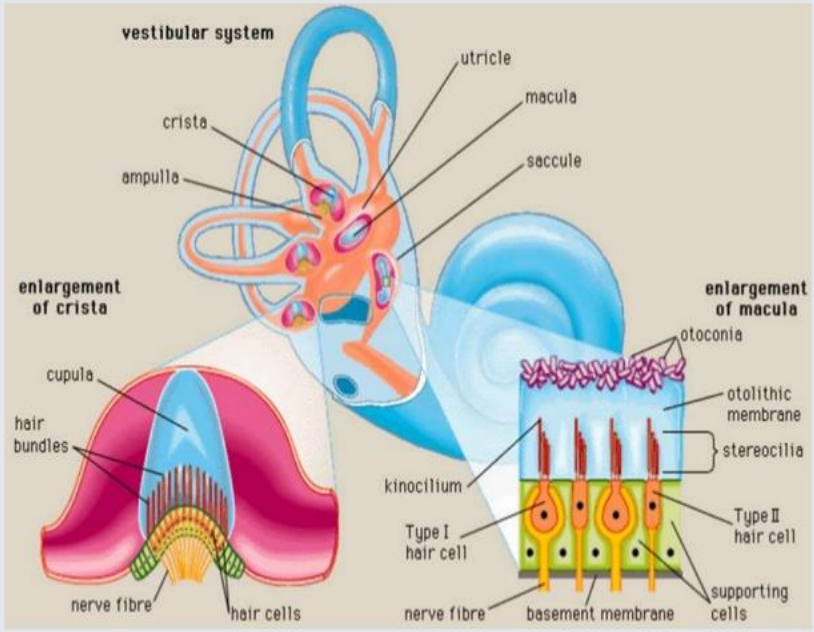
Ampullary crest

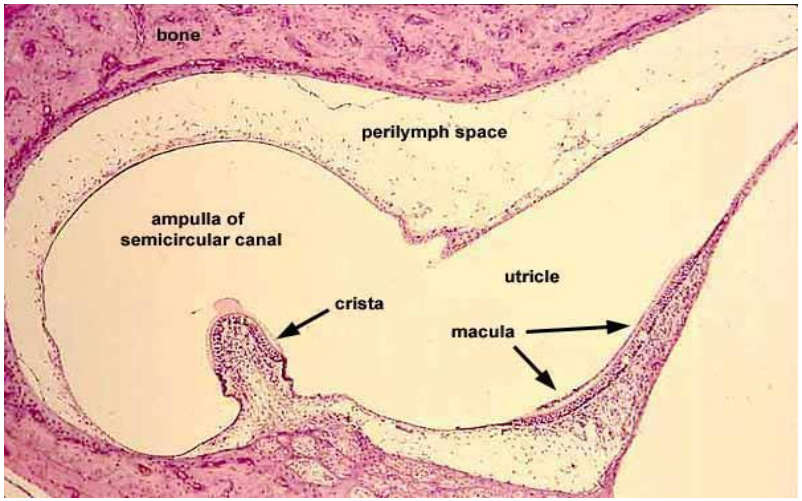
→ angular accelerations

Utricular and saccular maculae

→ linear accelerations

→ gravity



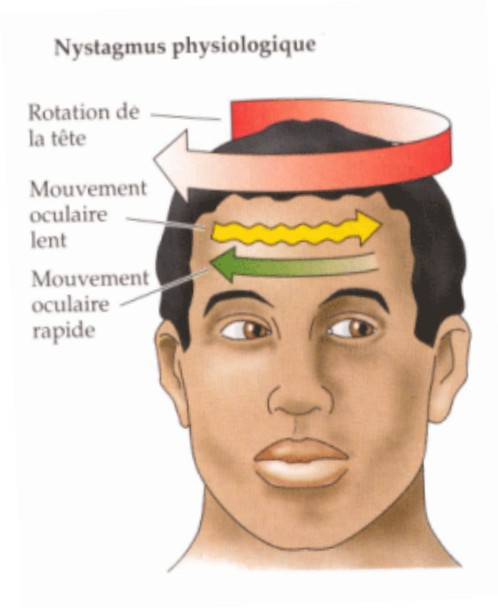


Functions

- Gaze stabilization (VOR)
- Body/head stabilization and postural adjustment (VCR – VRS)

Vestibulo ocular reflex

- Stabilizes gaze during head movement
- Physiological nystagmus
- Generated by vestibular receptors
  - aVOR (SCCs)
  - tVOR (otolithic organs)
- Most used in daily clinical practice is horizontal aVOR

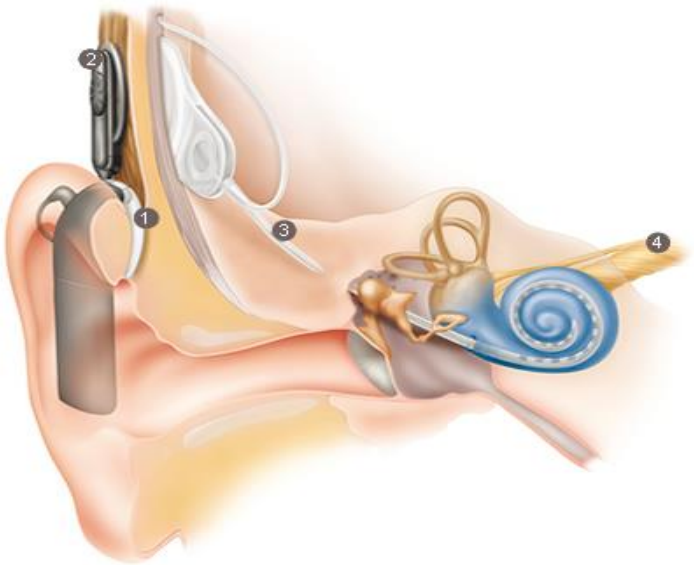


VESTIBULAR EVALUATION IN SEQUENTIALLY IMPLANTED CHILDREN: *OBJECTIVE*

- The ***objective*** of this study is to evaluate

  - **the impact of cochlear implants on vestibular function in sequential implantation**

  - the risk of inducing a complete areflective status after second implantation



POPULATION

- From January 2012 to May 2015
- 26 candidates for contralateral implantation

Population characteristics (n=26)	
Mean age at first examination	6,75 (range: 1 - 13)
Brand of Implants	Cochlear
Cochleostomy insertion site	Antero-inferior
Etiology	
Syndromic	6
Genetic	7
Postmeningitic	2
CMV	1
ANSD	2
Unknown	8
CT scan, MRI	
Normal	19
Vestibular malformation	3
Cochlear malformation	1
Cochleo-vestibular malformation	3

METHOD

- Vestibular assessment ***before*** and ***3 months after*** 2nd implantation

➢ ***Complete vestibular clinical evaluation***

- Patient history (vestibular symptoms?)
- Postural stability, gait, and coordination
- Oculomotor assessment
- Spontaneous or gaze-evoked nystagmus
- Short neurological evaluation

➢ ***Horizontal canal evaluation*** (aVOR)

- Halmagyi test
- VOR testing on rotary chair
- **Bicaloric testing** with videonystagmoscopy

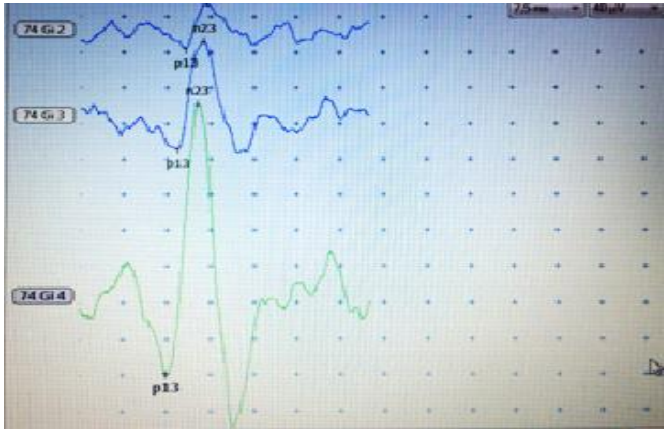
➢ ***Otolithic evaluation***

- **cVEMP exam** with tone bursts

VESTIBULAR EVOKED MYOGENIC POTENTIALS: C-VEMPS

- Elicited from the SCM muscle
- Assesses saccular and inferior vestibular nerve function (sacculospinal pathway)
- Recorded with standard ABR equipment and surface electrodes
- Stimulus: 500 Hz tone bursts, 74 dBnHL bone conduction
- P1-N1 wave, amplitude and latencies

- ***Pitfalls***: - SCM contraction
  - Otitis media with effusion



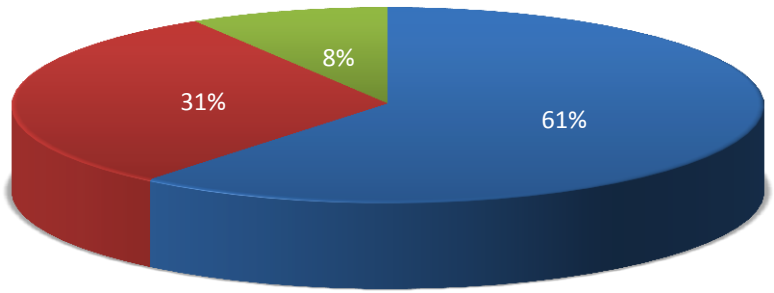
CALORIC TEST

- Bithermal caloric stimulation: ear irrigation at 30°c and 44°c during 30 sec
- Observation of eye movements by videonystagmoscopy (or VNG)
- Information about lateral SCCs only
- Canal paresis if Jonkees formula values ≥ 15%
- Not well tolerated in young children

Vestibular status before contralateral implantation

Before contralateral implantation

- ► 31% normal bilateral vestibular function
- ► 61% unilateral or bilateral hyporeflexia
- ► 8% bilateral areflexia



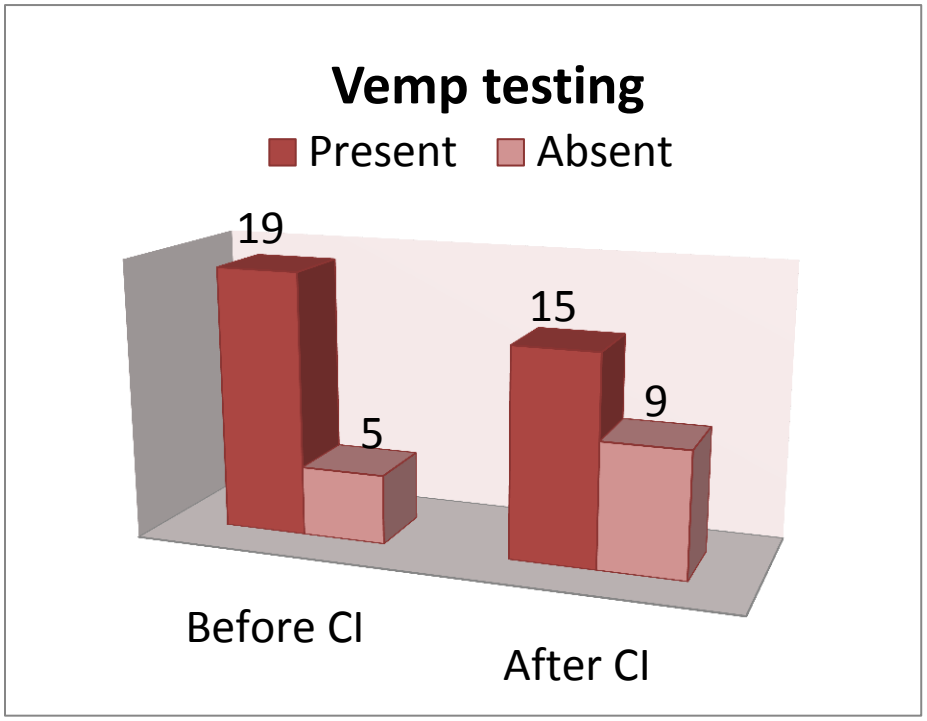
→ High prevalence of vestibular dysfunction in our test group (n=26)

Results c-VEMP testing
Otolithic function modifications

VEMP responses

- Before 2nd CI: present in 19 patients
- After 2nd CI: present in 15 patients

→ **4/24 patients lost their VEMP responses (16%)**

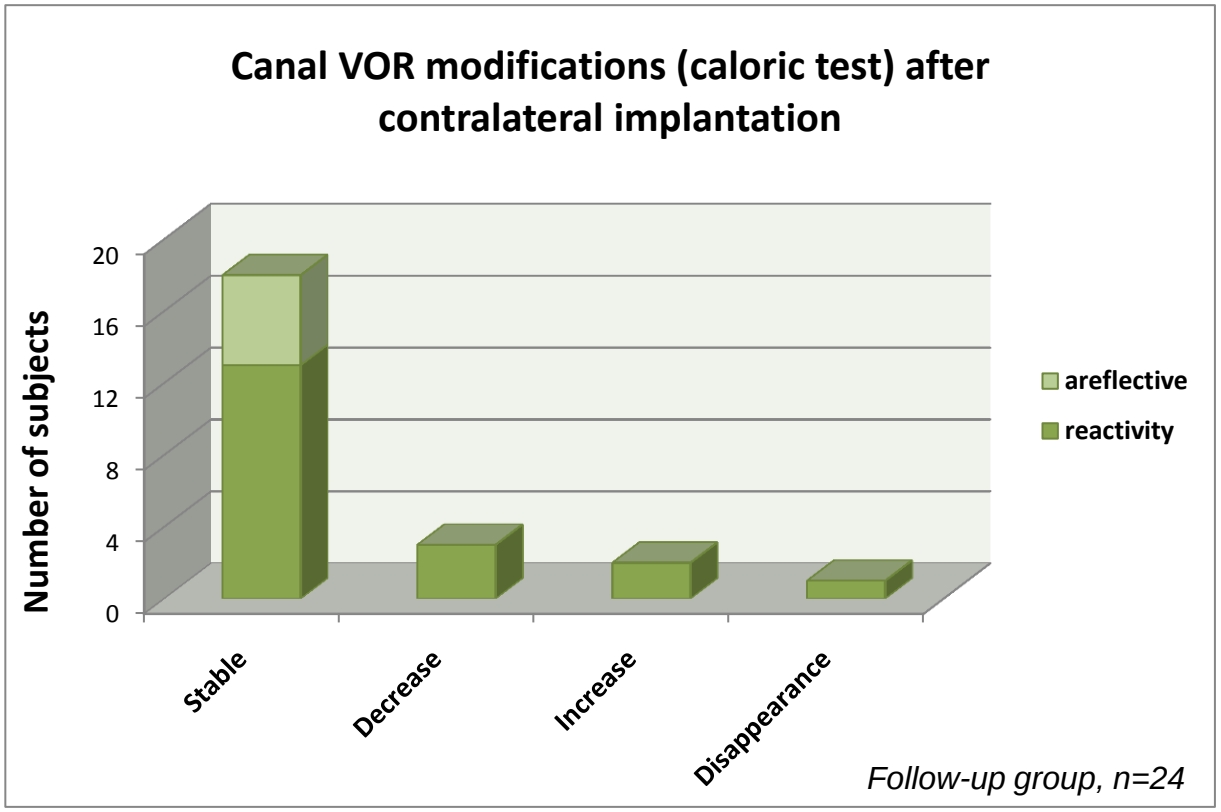


Follow-up group, n=24

Results bicaloric testing
Horizontal canal function modifications

- Identical response: 18 patients *(13 reactive – 5 areflective)*
- Decrease: 3 patients
- Increase: 2 patients (hyperexcitability?)
- Disappearance: 1 patient

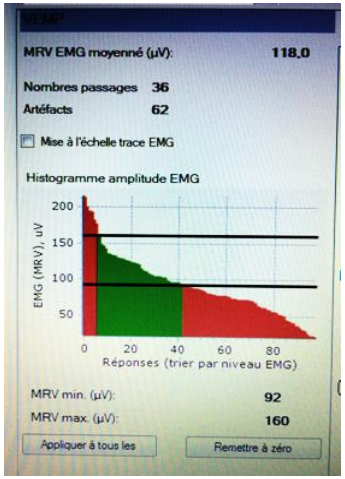
→ **Different responses in 6/24 patients**

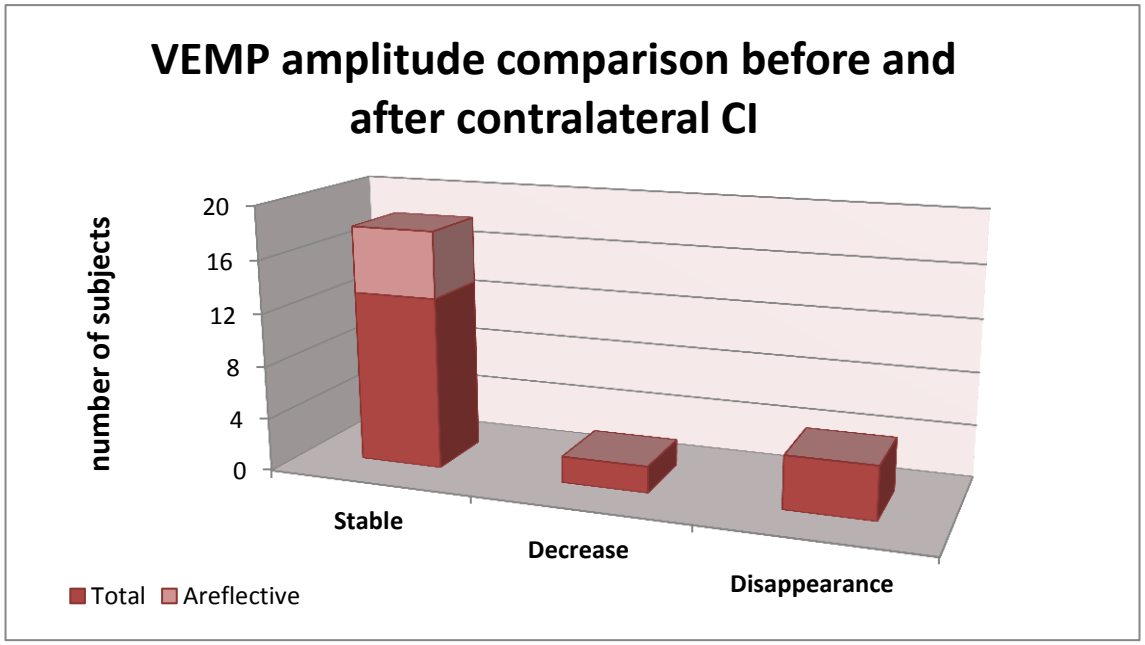


DISCUSSION: CVEMP TESTING

Only **presence/absence** of cVEMP response was considered

- Thresholds could not be determined for all children
- Amplitude strongly depends on muscle contraction
- Biofeedback allows more precision



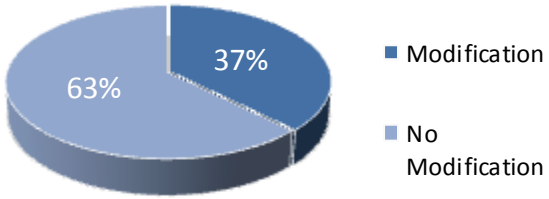


DISCUSSION

- Vestibular status before first implantation is mostly unknown

- Compliance for VEMP testing was high, in contrast to compliance for caloric testing

- **37% of patients had their vestibular function modified** after their second implantation. However, **none of the patients with a normal vestibular status** at the 2nd implanted ear **became areflectic**



- **12% (3/24) patients completely lost their saccular function and 4% (1/24) became areflectic** after second implantation

- In patients with vestibular function modifications, **one third manifested transitory postoperative vestibular symptoms (3/9) .**
  Age-related? *(Chi-square test, p = 0,079)*

- **No significative correlation between vestibular loss and inner ear malformation**
  (Chi-square test, p = 0,8077)

VESTIBULAR EVALUATION IN SEQUENTIALLY IMPLANTED CHILDREN:
CONCLUSIONS

- High prevalence of vestibular dysfunction among our test group
- Horizontal canal function seems more preserved than saccular function
- 16 % of our children presented a loss of saccular and/or horizontal canal function after second implantation.
  Amongst these children, which percentage will have balance problems in older age?
- Larger series of patients are required in order to confirm our results about the impact of contralateral implantation on balance function
- This study confirms the importance of vestibular assessment before sequential implantation to prevent bilateral vestibular areflexia, especially if
  - there is hyporeflexia on the not yet implanted ear
  - independent walking is not acquired yet

CLINICAL CASE

26 months old girl, bilateral sequential cochlear implantation

Horizontal canal areflexia

THANK YOU
FOR YOUR ATTENTION

Vestibular evaluation in sequentially implanted children: preliminary results

Complete test results

Patients	Etiology	P1/N1 CI contralat, pre	P1/N1 CI contralat, post	Variation A°	Caloric test pre 2nd CI	Caloric test after 2nd CI	Imaging
1	Unknown	✓	65 db	=	Normal	Normal	Vestibular dysplasia
2	Genetic	✓	65 db	=	Hyporeflexia left	Symmetrization (**right** ↘)	Normal
3	Syndromic	0	0	=	Areflexia	Areflexia	Normal
4	Syndromic	74 db	0	✖	Bilateral hyporeflexia	Bilateral hyporeflexia	Normal
5	Unknown	✓	60 db	=	Hyporeflexia **right**	Normal (**right** ↗, hyperexcitability?)	Normal
6	Genetic	✓	65 db	↘	Normal	Normal	Normal
7	Post meningitic	✓	60 db	=	Hyporeflexia left	Symmetrization (**right** ↘)	Cochlear ossification
8	Syndromic	✓	65 db	=	Areflexia **right**	Areflexia **right**	Normal
9	Unknown	0	0	=	Hyporeflexia left	Hyporeflexia left	Normal
10	Unknown	0	0	=	Hyporeflexia **right**	Hyporeflexia **right** (but ↗ right)	Normal
11	Genetic	74 db			Normal		Normal
12	Unknown	✓			Important hyporeflexia left		LVAS
13	Syndromic	60 db	60 db	=	Normal	Normal	cochleo-vestibular dysplasia
14	Syndromic	0	0	=	Bilateral hyporeflexia +++	Bilateral hyporeflexia +++	Normal
15	Genetic	65 db	74 db	=	✕ (tubes)	Normal	Normal
16	Unknown	60 db	65 db	=	Normal	Normal	Normal
17	Genetic	✓	✓	=	Normal	Normal	Normal
18	Unknown	✓	✓	=	Hyporeflexia left	Hyporeflexia left	Normal
19	ANSD	✓	✓	=	Hyporeflexia right	**Bilateral** hyporeflexia	Normal
20	ANSD	✓	0	✖	Areflexia	Areflexia	Vestibular dysplasia
21	Genetic	✓	✓	=	✕ (tubes)	Hyporeflexia left	Normal
22	Post meningitic	0	0	=	Areflexia	Areflexia	Cochleo - vestibular ossification
23	Genetic	✓	0	✖	Bilateral hyporeflexia	Bilateral hyporeflexia	Normal
24	unknown	✓	✓	=	Normal	Normal	Normal
25	Syndromic	✓	0	✖	Hyporeflexia **right**	**Areflexia**	LVAS + cochleo-vestibular dysplasia
26	CMV	✓	✓	↘	Areflexia	Areflexia	Normal