Vestibular Assessments Predict Intraoperative Pathology but Not Cochlear Implant Outcomes

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Background

While cochlear implantation (CI) is a relatively safe procedure, vestibular dysfunction from iatrogenic insertion is a notable complication.[1] While prior studies have reported the effect of implantation on postoperative vestibular function,[2] there has yet to be an evaluation of vestibular findings as a predictor of clinical factors, intraoperative pathology, and hearing and speech recognition outcomes.

This study aimed to determine the association between abnormal videonystagmography (VNG, reflecting horizontal canal and superior vestibular nerve function) and cervical vestibular evoked myogenic potentials (cVEMP, reflecting saccule and inferior vestibular nerve function) to preoperative clinical profile, intraoperative pathology, and post-implant hearing outcomes among adults undergoing CI.
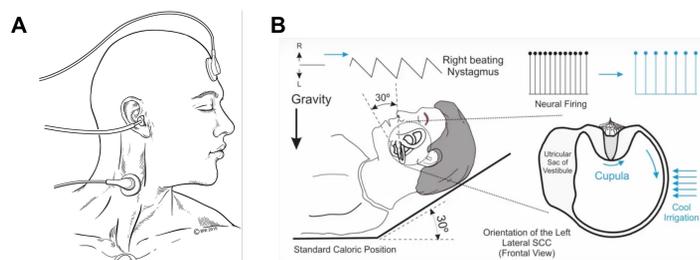

Figure 1. Schematic representation of (A) cVEMP and (B) Caloric testing on VNG.

Methods

- Retrospective cohort study of patients who underwent CI at a single tertiary-care institution (LSUHSC) from 2017 to 2020

- Demographics, hearing history, subjective vestibular complaints, objective vestibular testing, intraoperative details, and hearing outcomes were assessed

Table 1. Subject Characteristics

	Abnormal VNG, n=37 (%)	Normal VNG, n=88 (%)	Abnormal cVEMP, n=53 (%)	Normal cVEMP, n=72 (%)
Mean age at implantation (range)	58 (20-84)	62 (18-88)	61 (20-88)	60 (18-88)
Sex (male %)	20 (54)	45 (51)	30 (57)	35 (49)
Type of implant				
Primary	22 (59)	75 (85)	37 (7)	60 (83)
Sequential	11 (30)	13 (15)	12 (23)	12 (17)
Bilateral	2 (5)	0	2 (4)	0
History				
Head trauma	2 (5)	3 (3)	2 (4)	3 (4)
Meningitis	11 (42)	0	10 (19)	1 (1)
Noise exposure	9 (27)	32 (35)	16 (30)	25 (35)
Otosclerosis	3 (8)	1 (1)	4 (8)	0
CSOM	4 (14)	7 (7)	10 (19)	1 (1)
Prior ear surgery	6 (19)	7 (8)	11 (21)	2 (3)
Preoperative symptoms	22 (59)	9 (10)	23 (43)	8 (11)
Postoperative symptoms*	12 (32)	10 (12)	13 (25)	9 (13)
Persistent symptoms**	10 (29)	8 (9)	9 (19)	9 (13)

Age listed in years. VNG=videonystagmography, cVEMP=cervical vestibular evoked myogenic potentials, CSOM=chronic serous otitis media; *=within 1 month postop, **=beyond 6 months postop

Results

Table 2. Hearing and Speech Recognition Outcomes based on VNG

	Pre-implant			Post-implant		
	Abnormal VNG (n=37)	Normal VNG (n=88)	*P*-value	Abnormal VNG (n=37)	Normal VNG (n=88)	*P*-value
PTA	94.8±17.1	88.0±14.9	0.028	22.6±3.56	24.5±9.14	0.242
WRS	32.4±25.4	22.8±19.5	0.081	55.0±21.8	62.4±24.3	0.140
SRT	80.7±19.7	70.8±19.8	0.025	19.7±4.83	21.3±5.35	0.133
CNC_{words}	17.7±16.9	19.6±15.5	0.625	66.2±10.6	65.1±10.4	0.905
$CNC_{phonemes}$	30.9±23.6	39.0±22.3	0.149	79.0±16.7	79.7±16.4	0.908
AzBio	18.9±23.3	21.4±25.8	0.623	50.9±30.3	69.3±30.3	0.135

PTA =pure tone average, WRS=word recognition score, SRT=speech reception threshold, CNC=consonant-nucleus-consonant

Table 3. Hearing and Speech Recognition Outcomes based on cVEMP

	Pre-implant			Post-implant		
	Abnormal cVEMP (n=53)	Normal cVEMP (n=72)	*P*-value	Abnormal cVEMP (n=53)	Normal cVEMP (n=72)	*P*-value
PTA	95.5±48.4	86.6±47.7	0.309	25.0±11.5	23.3±4.60	0.272
WRS	32.0±19.5	21.7±19.2	0.027	56.5±30.7	62.5±30.2	0.323
SRT	81.2±40.6	68.9±40.2	0.125	21.1±10.9	20.7±10.4	0.846
CNC_{words}	18.1±11.8	19.6±11.5	0.580	60.9±27.0	68.1±26.6	0.347
$CNC_{phonemes}$	32.9±19.5	39.0±19.1	0.176	75.5±32.3	82.0±31.8	0.476
AzBio	17.7±16.4	22.1±19.8	0.208	68.6±33.7	33.7±33.3	0.392

PTA =pure tone average, WRS=word recognition score, SRT=speech reception threshold, CNC=consonant-nucleus-consonant

Table 4. VNG results

Type of response	VNG, n=37 (%)
Unilateral weakness	15 (41)
Bilateral weakness	10 (27)
Unilateral absent response	6 (16)
Bilateral absent response	5 (14)
Spontaneous nystagmus	1 (3)

Table 5. cVEMP results

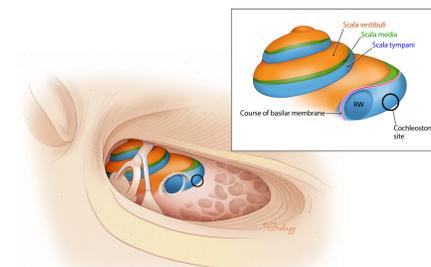| Type of response	cVEMP, n=53 (%)
Reduced amplitude	4 (8)
Decreased threshold	1 (2)
Unilateral absent response	17 (32)
Bilateral absent response	31 (58)

Figure 2. Illustration of round window and optimal cochleostomy site for CI insertion. Permission granted by Illustrator ©Chris Gralapp.
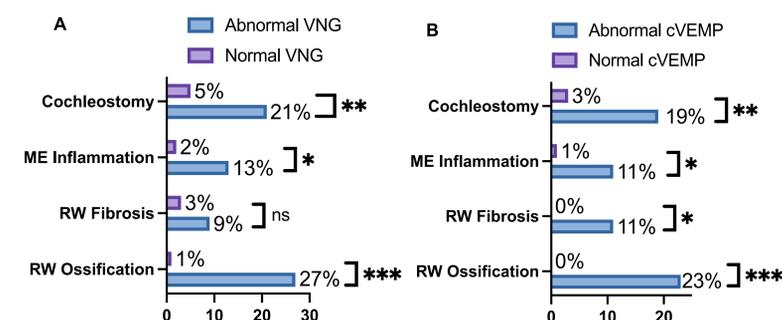

Figure 3. Association between pre-operative vestibular results and intraoperative pathology. (A) VNG (B) cVEMP   * p <0.05, **p < 0.01, ***p <0.001. ME = middle ear, RW = round window

Discussion

- Preoperative vestibulopathy was not associated with post-implant hearing and speech recognition outcomes
- Abnormal pre-operative vestibular testing among adult cochlear implant candidates correlated with vertiginous symptoms pre-operatively but only VNG correlated with symptoms postoperatively
- History of meningitis and presence of labyrinthitis ossificans correlated with abnormal VNG and cVEMP and subjective vestibular dysfunction, as expected[3]
- The association between abnormal vestibular findings and presence of intraoperative pathology was likely due to high rates of patients with a history of labyrinthitis
- Patients with abnormal vestibular testing were more likely to require a cochleostomy[4] to address cochlear obstruction
- CI post-meningitis resulted in worse mean hearing outcomes[5] in part due to partial insertion in some patients with labyrinthitis ossificans
- Abnormal preoperative vestibular findings may assist surgical planning for CI patients with a history of labyrinthitis

Conclusions

Pre-implantation vestibular assessments may assist operative planning to anticipate pathologies including round window fibrosis/ossification or middle ear inflammation, which may require cochleostomy for optimal electrode insertion. While abnormal vestibular testing may reflect baseline hearing status, it does not appear to predict post-implant hearing and speech recognition outcomes.

References

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