Bone-Anchored Hearing-Aid Long-Term Results
Sensorineural Hearing Loss and Quality of Life

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Introduction

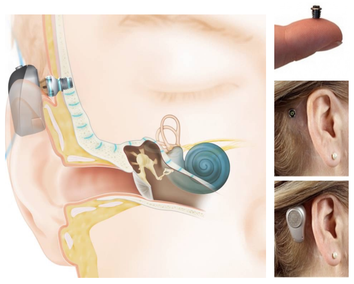
Which patients benefit from the BAHA implant ?

- Unilateral or bilateral conductive or mixed hearing loss
  - Transcranial bone conduction transmits sounds to **both** ears
- Unilateral sensorineural hearing loss
  - Transmits sounds to **contralateral** functional ear

Problem. Although patients usually appreciate their implant, many patients decide to remove their BAHA implant or cease to use the processor.

Objectives.

- Which audiological risk factors lead to the removal of the abutment?
- Which audiological risk factors lead to stop using the processor?
- Are there audiological factors linked to patient satisfaction?



Methods and Materials

- Tertiary care monocentric retrospective chart review and phone interviews.
- **Inclusion criteria**
  - Adult patients from the CHUM otolaryngology clinic
  - Operated for a BAHA implant from 2003 to 2021
    - The end of follow-up corresponds to the last day of data collection
- Patient satisfaction and post-implantation quality of life were evaluated with the **Abbreviated Profile of Hearing Aid Benefit survey** (APHAB) and **Glasgow Benefit Inventory** (GBI)

- Statistics are performed with SPSS 28.0 software.
- Acronyms: CHA (conventional hearing aid), ABG (air bone gap), PTA (pure-tone audiometry), PCC (pearson correlation coefficient).

Results

Table 1. Patient characteristics and surgical indications

	N (%) (total = 167)
Implants (ears):Patients	167:159
Male:female	69:90
Mean age at surgery (years) ± SD	52.28 ± 15.21
Mean follow-up time (years) ± SD	8.28 ± 5.28
Implant laterality - Left: Right	80:87
Binaural hearing aid	
Bilateral BAHA	17 (10.18)
Conven. hearing aid on contralateral side	35 (20.96)
SNHL etiology	81 (48.5)
Vestibular schwannoma resection	**50 (29.9)**
Idiopathic sudden SNHL	**15 (9.0)**
Congenital	5 (2.4)
Ménière disease	4 (2.4)
Other surgical intervention	3 (1.8)
Acoustic trauma, Mumps virus	4 (2.4)
Conductive HL etiology	86 (51.50)
Radical mastoidectomy	**36 (21.6)**
Congenital external auditory canal atresia	**29 (17.4)**
Chronic otitis +/- mastoiditis	**18 (10.8)**
Kartagener syndrome	2 (1.2)
Acquired external auditory canal stenosis	1 (0.6)
PTA bone conduction thresholds - Mean (SD)	
Ipsilateral ear to BAHA	49.0 (28.0)
Controlateral ear to BAHA	23.7 (19.3)
PTA air conduction thresholds - Mean (SD)	
Ipsilateral ear to BAHA	93.2 (24.8)
Controlateral ear to BAHA	38.49 (33.9)
Patients reached by phone	134 (80.2)
Survey response rate: APHAB:GBI	103:112

Results (*continued*)

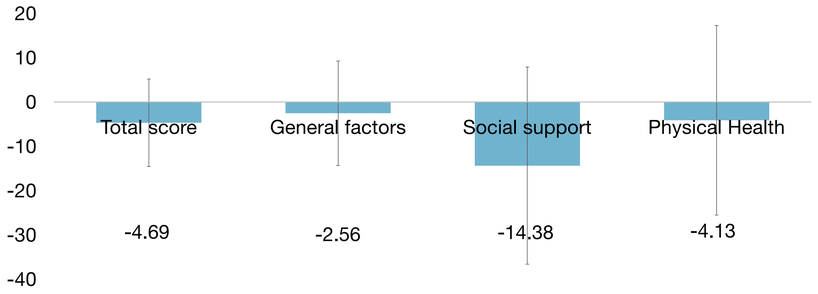


Figure 1. Descriptive results of **GBI scores**, all patients combined. A negative score indicates a negative impact on quality of life.

Table 2. Audiologic risk factors associated with **abutment removal** (n = 19/167)

	N (%)	Hazard ratios (95% CI)	p-value
Binaural hearing aid with BAHA (n = 17)	2 (1.2)	0.56 (0.15-2.09)	0.390
Binaural hearing aid with conventional hearing aid (n = 35)	3 (1.8)	1.49 (0.31-7.07)	0.615
No binaural hearing aid (n = 115)	14 (8.4)	1.87 (0.49-7.15)	0.358
Pre-operative softband trial (n = 82)	10 (6.0)	1.77 (0.68-4.67)	0.243
Digital processor (VS analog) (n = 131)	3 (1.8)	2.31 (0.73-7.27)	0.152
No. hours/day of processor use			
Rarely (n = 23)	1 (0.6)	1.23 (0.81-1.88)	0.330
< 10h/week (n = 24)	2 (1.2)		
10-40h/week (n = 25)	4 (2.4)		
>8h/day (n = 79)	8 (4.8)		
Pre-operative ABG			
BAHA ear	.	0.99 (0.96-1.02)	0.605
Contralat. ear		0.99 (0.97-1.01)	0.398
Pre-op PTA *bone* conduction			
BAHA ear	.	**1.02 (1.00-1.03)**	**0.017**
Controlat. ear		1.01 (0.98-1.03)	0.672
Pre-op PTA *air* conduction			
BAHA ear	.	**1.02 (0.99-1.04)**	**0.054**
Controlat. ear		0.99 (0.99-1.00)	0.606

Table 3. Risk factors associated with the deliberate decision to stop using the processor**.** For ABG and PTA results, every odd ratio increase corresponds to a 10 dB increase.

Variable	Processor still used (n = 100) N	Odds ratio (95% CI)	p-value	Processor use ceased (n = 55) N	Delay (months) (av. ± SD)	Odds ratio (95% CI)	p-value
Concomitant controlateral BAHA (instead of CHA)	15	0.36 (0.07-1.96)	0.064	9	NA	3.07 (0.34-27.85)	0.088
No binaural hearing aid (instead of BAHA)	59	5.04 (2.00-25.47)		44	41.2 (47.8)	0.17 (0.02-1.38)	
No binaural hearing aid (instead of CHA)	59	1.80 (0.84-3.87)		44	41.2 (47.8)	0.51 (0.22-1.17)	
Pre-operative softband trial	44	0.40 (0.20-0.78)	**0.007**	31	54.8 (47.9)	1.73 (0.87-3.44)	0.115
Adapting the program to the environment	58	0.37 (0.19-0.73)	**0.004**	15	24.5 (31.1)	3.18 (1.52-6.69)	**0.002**
Digital processor	83	0.29 (0.11-0.72)	**0.008**	39	36.0 (36.8)	2.20 (0.96-5.02)	0.061
Hours/week of processor use							
Rarely	8	0.50 (0.36-0.69)	**< 0.001**	15	53.3 (53.5)	1.71 (1.26-2.32)	**0.001**
< 10h	16			8	41.5 (35.1)		
10-40h	13			11	36.0 (39.2)		
>40h	60			15	31.4 (39.3)		
Pre-operative ABG							
BAHA ear	.	**0.78 (0.62-0.97)**	**0.023**	.	.	1.57 (1.21-2.03)	**0.001**
Contrala. ear		0.68 (0.55-0.84)	**< 0.001**			1.39 (1.10-1.76)	**0.007**
Pre-op PTA *bone* cond.							
BAHA ear	.	**1.19 (1.03-1.36)**	**0.015**	.	.	0.82 (0.71-0.95)	**0.009**
Contralat. ear		0.75 (0.61-0.94)	**0.011**			1.12 (0.90-1.38)	0.318
Pre-op PTA *air* conduction							
BAHA ear	.	**1.31 (1.13-1.51)**	**< 0.001**	.	.	0.78 (0.67-0.91)	**0.002**
Contralat. ear		**0.75 (0.66-0.85)**	**< 0.001**			1.21 (1.07-1.37)	**0.002**

Results (*continued*)

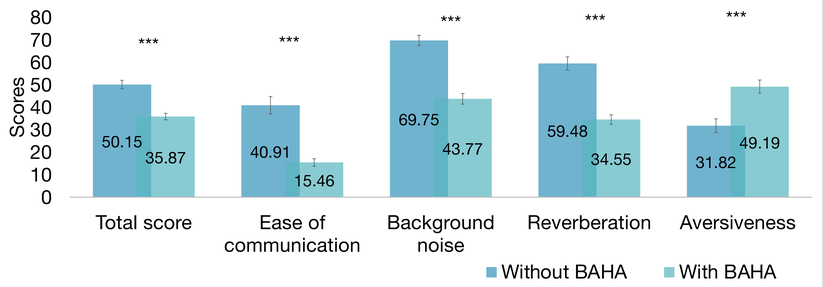


Figure 2. Impact of the BAHA on hearing-related quality of life, assessed with the **APHAB survey.** A *lower* APHAB score reflects *better* results.

Tables 4. Impact of audiological variables on (a) **GBI scores** and (b) **APHAB scores** (when the processor is worn).

Variables	Total score N	PCC	p-value	General factors N	PCC	p-value	Social support N	PCC	p-value
Age at surgery	101	-0.44	0.661	102	0.10	0.305	101	-0.27	**0.005**
Pre-op ABG									
BAHA ear	76	-0.19	0.097	76	-0.08	0.507	76	-0.26	**0.023**
Contralat. ear	79	-0.31	**0.005**	79	-0.25	**0.026**	79	-0.38	**0.001**
PTA *bone* conduction									
BAHA ear	77	0.27	**0.018**	77	0.29	**0.011**	77	0.16	0.157
Contralat. ear	78	-0.19	0.089	78	-0.15	0.179	78	-0.24	**0.038**
PTA *air* conduction									
BAHA ear	100	0.17	0.087	101	0.28	**0.004**	100	0.07	0.513
Contralat. ear	98	-0.29	**0.004**	99	-0.22	**0.027**	98	-0.41	**< 0.001**

Variables	Ease of communication N	PCC	p-value	Background noise N	PCC	p-value
Age at surgery	82	0.17	0.137	84	-0.021	0.852
Pre-op ABG						
BAHA ear	67	0.34	**0.005**	68	-0.040	0.744
Contralat. ear	67	0.26	**0.033**	67	-0.344	**0.004**
PTA *bone* conduction						
BAHA ear	68	-0.22	0.069	69	0.251	**0.038**
Contralat. ear	66	0.33	**0.006**	66	-0.039	0.756
PTA *air* conduction						
BAHA ear	81	-0.44	0.696	83	0.227	**0.039**
Contralat. ear	79	0.40	**<0.001**	81	-0.174	0.120

Discussion

- In our sample, an important proportion of patients received an implant for a **SNHL indication** (vestibular schwannoma resection) (**table 1**).

- The BAHA significantly improves **subjective hearing benefit** (**fig. 2**)
  - A **higher PTA air and bone conduction** in the **controlat. ear** raises ease of communication (**table 4b**), as the general cochlea reserve is less severe. The sound is efficiently transmitted to both ears transcranially. This correlates with:
    - An ipsilateral ear with higher air and bone conduction, which favors the tolerance to background noise (**table 4b**)
    - There is no significant correlation with the decision to remove the abutment, however our sample is small (n = 19).
    - Although patients tend to simply stop using their processor instead of having their abutment removed (**table 3**).

- The BAHA significantly worsens the **aversiveness score** (**fig. 2**), as the processor amplifies *all* sounds when turned on. This may explain why the BAHA does **not** improve **quality of life** (**fig. 1**). However, high standard deviations reflect the large variability between patients.

Conclusion

- The BAHA should be reserved for patients with a **strict conductive hearing loss**, as it is not beneficial for patients with SNHL or with a high SNHL component in the controlat. ear, as it reflects a low cochlear reserve.

References

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