EVALUATION OF CONTINUOUS FLOW ADAPTOR IN BEHIND-THE-EAR HEARING AID USERS

Reg.NolM9219

AN INDEPENDENT PROJECT SUBMITTED AS PART FULFILMENT OF 1st M.Sc.(SPEECH & HEARING) TO THE UNIVERSITY OF MYSORE.

ALL INDIA INSTITUTE OF SPEECH AND HEARING : MYSORE-570 006.

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The twins (Chetan and Chechi)

Who encapsulate me with

warmth and affection whenever I

need it the most.

****

CERTIFICATE

This is to certify that the Independent Project entitled: "Evaluation of Continuous Flow Adaptor in Behind-the-ear hearing aid Users" is a bonafide work done in part fulfilment for the First Year Degree of Master of Science (Speech and Hearing), of the student with Reg.No.M9219.

Mysore
May 1993

Dr.(Miss) S.Nikam
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CERTIFICATE

This is to certify that the Independent Project entitled: Evaluation of continuous Flow Adaptor in Behind-The-Ear Hearing Aid Users has been prepared under my supervision and guidance,

Mysore
May 1993

Dr,(Miss) S.Nikam
GUIDE

DECLARATION

I *hereby* declare that the Independent Project entitled: Evaluation of Continuous Flow Adaptor in Behind-The-Ear Hearing Aid Users is the result of my own study under the guidance of Dr.(Miss) S.Nikam, Prof. & Head of the Department of Audiology, & Director, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier at any University for any other Diploma or Degree.

Mysore

May 1993 Reg.No.M9219.

ACKNOWLEDGEMENT

I am grateful to Dr.(Miss) Shailaja Nikam, Prof. & HOD, Dept. of Audiology; and Director, All India Institute of Speech and Hearing, Mysore for her excellent counsel and guidance to me in the preparation of this project.

The world would mean Darkness to me if not for the guiding light shown by 'U' - dear parents.

Dearest Manjula Madam "Hats off to 'U', without 'u' I would not have finished even ¼th of my present work.

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UR fine touch is a grand finale for my project Dear Akka.

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INTRODUCTION

Science moves out slowly
Creeping on from point to point

Tennyson

A sound hearing is a vital/ everyday link with the world. In the drama of life one seldom gives it a second thought. Breaking this isolated world of sound of silence to the world of resound the miracle of technological advancement has created new avenues for better hearing. The field of earmold is one such, fostering the physical cum acoustic needs of the ear.

An earmold sometimes called the earpiece is a plastic insert designed to conduct the amplified sound from the hearing and receiver into the ear canal as efficiently as possible (Langford, 1975).

An earmold is an integral part of the amplification system and must be chosen and evaluated carefully. Hearing impaired individuals may require minor modifications of the characteristics of a given hearing aid in order to use it more comfortably and effectively. Desired changes can be accomplished by modification of the earmold ways of producing minor changes in frequency response include changing the diameter or length of the tubing. Shortening or lengthening the canal portion of the earmold. In addition to changing frequency response characteristics the modification also may have noticeable effects on speech intelligibility, quality judgements, listener preference and comfort.

All personal amplification systems other than the body level and all in-the-ear type utilize plastic tube to couple the hearing aid and the ear mold. Tube fittings of the hearing aids also describes the practise tube extending into the external auditory canal for the purpose of directing amplified sounds to the tympanic membrane (Stable and Nunby, 1992).

The rationale behind tube fitting is to obtain maximum amplification in the described frequency region without occluding the ear and without getting an acoustic feedback (squeal). Hence the tube fitting attempts to take maximum advantage of -

1) Natural response of the ear canal
2) Of low frequency suppression created by this form of maximum venting.
3) Elimination of the insertion loss created by placing an earmold in the ear canal.

In the 1950s tube style earmolds were developed. The tubes were glued into the bore of the earmolds for retention. Many new earmolds configurations have been developed which offer dispensers physical and acoustic options for providing their clients with increased comfort and better amplification. There are approximately 63 such options. The CFA (continuous flow adaptor) is a new invention, where it is possible for the dispenser to snap-on a new tubing .What is a continuous flow adaptor earmold?

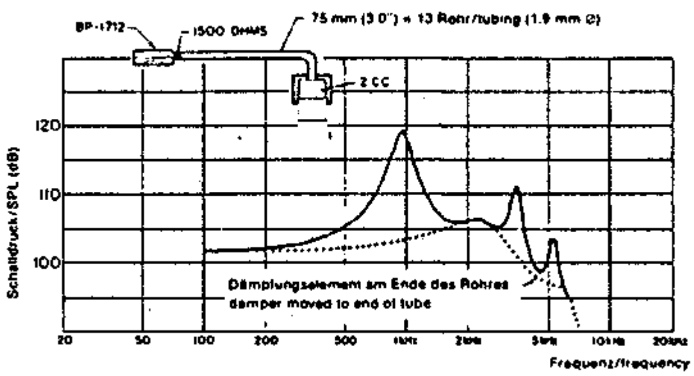
Continuous flow adaptor family of earmolds were developed by Norman Schlaegel (1982).

According to him the continuous flow adaptor is nothing but where the tubing is coupling a high impedance receiver (in the aid) to a low impedance load (in the space from the earmold tip to the ear drum). Once they are coupled to an earmold many behind-the-ear aid produce resonant peaks between 1000 Hz and 10,000 Hz. (Fig.I Undamped tubing resonance).

They are also termed as elbows or angle pieces which are used where straight tubing is used to link the earmold to the post-auricular hearing aids. Use of connector avoids kinking of the tube (Nikam, Sowmyamala, Manjula, 1989) "Present status of earmold technology[11] presented at IIIrd Annual National Seminar at All Yavar Jung National Institute for the Hearing Handicapped, Bombay).

By Joel M. Mynders

Figure 1



Undamped Tubing Resonance

REVIEW OF LITERATURE

The primary appeal of the CFA (Continuous flow adaptor) earmolds have been the acoustics of the continuous flow adaptors earmolds, the snap in feature of the CFA molds (product catalogue of Ternen's Prosthetics, Australia).

1. It has a uniform internal diameter from the tip of the adaptor to the end of the tubing. The internal diameter is unchanged even when the adaptor is in place in the earmold.

   The uniform internal diameter is responsible for the continuous flow of amplified sound, which in turn results in the smoothness, consistency and high frequency emphasis of the coupling system.

2. The CFA snaps and locks into the earmold.

   The snap in and lock features makes it easy to clean the earmold, replace the adaptor and make the adjustments. It eliminates the need to glue in tubing.

3. The adaptor has an 80° angle.

   The angle of the adaptor assumes that the tubing lies closely along the head for better fit and cosmetic appearance.

4. The adaptor can be used with varied styles of earmolds.
5. Tubing usable with the CPA includes the 13STD, 13 thick, 13 double wall thick.
6. It can be used with hard and soft acrylic and polysheer materials.
7. Can be made to suit special acoustic type earmolds.

According to a field report by Mynders (1983), the CPA system incorporates the acoustic options of the socailed new earmold technology and provides dispensers with an easy "plumbing service" concept by using a patented snap on adaptor tubing.

Tubing replacement has always involved completely removing the old tubing and installing new tubing. Sometimes the removal of the tubing necessitates using a tool called a reamer. In difficult cases failure to remove all of the old tubing results in bumps in the newly installed tubing. If the interval diameter of the tubing is reduced or blocked in any way it will lessen the high frequency response.

Norman (1982) developer of the CFA system, made a continuous non-interrupted simple tubing diameter that could easily be replaced and would not interfere with traditional in-office earmold modifications such as grinding. Norman (1982) also believed that a system approach ie, one that provided for all styles occluded and non-occluded applications was essential, since most newer hearing aids have wide band receivers. The major goal in developing the CFA was consistency.

Acoustics:

A series of curves were reviewed to demonstrate CFA earmolds consistency from ear to ear (Norman). Four cases each were fitted with audiotone A-35 the difference in pinna size, external canal size and length of ear canal, there was a high degree of uniformity of response across the four cases, apparently due to the uniform construction of the CFA system. For comparison purpose the same four subjects were tested with earmolds made with standard 13 tubing which resulted in significantly greater variation.

CFA comparability;

Careful examination of the physical aspects of the entire CFA earmold system shows that each earmold has hard retainer ring that holds the actual elbow adaptor.

It also shows that the tubing is glued inside the elbow in a way that provides a continuous flow in the tubing and elbow when a tubing change is required with the CFA.system, the elbow adaptor and tubing are both changed.

One of the major advantage of CFA is that of alleviating dispenser problem with the multitude of earmold innovations was the foundations of its inventers goal. The CFA earmold system distills the innovative earmold configuration of the past ten years into a daily usage formant for dispensing.

Continuous Flow Adaptor - Case Report:

In Hynder's (1983) field report on the CFA earmold system, a copy of an audiologists report, another report on the results of the reevaluation examination of a 12 year old girl whose binaural fitting includes CFA earmolds was received.

The report was noted for the following observation (the patients) aided speech detection threshold was 25 dB and her aided responses to 5%. Warble tones range from 15 dB to 55 dB for 250 Hz through 4000 Hz. This is the first time in her history. She has responded to 4000 Hz tone with her hearing aids. The effect of these earmolds appears as it is intended "To expand high frequency amplifications".

According to Mynders (1984), if we crimp the tubing, enlarge the tubing or even shrink the tubing there are concomitant effects in the frequency response patterns, Norman's (19) method to achieve more uniformity was to create a consistent tubing diameter which he calls CFA or continuous flow adaptor.

Why does the inventor call this an adaptor? The reason is he has standardized the method of attaching the tubing to the earmold itself. In other words in the C5FA family of earmolds the tubing and its adaptor are always the same. When the molds are processed or hard plastic ring is embedded in the mold itself. The CFA tubing and adaptor are then shapped into this securely. By snapping, tubing into position all glueing is eliminated.

In an unpublished paper Norman(1982) reported that the following acoustical factors are a part of this CFA family of earmolds.

1. High frequency emphasis which promotes better understanding in noise and hightens clarity of speech.
2. Smoothness of the frequency response curve generated ie. if smoothes out sharp peaks and valleys.
3. Consistency/standardization of acoustic effects from earmold-to-earmold, minimal mold-to-mold variation.
4. Ability of the dispenser to modify the earmold for fit and comfort without loss of special acoustic effects.

Thus, this invention offers a family of earmolds that can make applying the new earmold technology an easy reality at the dispensing level.

According to Balaraju (1992), there is no significant difference between the electroacoustic characteristics of behind-the-ear (BTE) hearing aid using CFA *l* earmold and earmold with indigenous connector with tubing and earmold with quill bent.

Based upon a single case study Balaraju (1992) reported that BTE hearing aid with indigenous connector with tubing earmold gives gain upto 4 KHz earmold with quill bent gives gain,the gain upto 6 KHz whereas **CFA** earmold gives the gain upto 8 KHz.

NEED FOR THE STUDY

This study will enable us to know which there is any different in -

1) The electroacoustic characteristics of the BTE hearing aid using shell mold with CFA and shell mold with elbow,

2) The frequency response/range of the BTE hearing aid using CFA mold and shell mold with elbow.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METHODOLOGY

Selection of subjects: The subjects selected were all BTE hearing aid users who had moderate to moderately severe hearing loss. Six of them had hearing loss in left ear and four of them in the right ear,

sex: Five males and five females were tested,

Selection of hearing aids: The hearing aids used by all the seven subjects where Alps P80 ET(H), one of them used F80 ET (N) and two of them used.

Earmolds: A pair of custom shell earmolds were made for each of 14 subjects in a well equipped earmold laboratory,

Test environment : All tests were carried-out in an air-conditioned sound-treated room. The ambient noise levels inside the room were within permissible levels (ANSI-5 3,1-1977).

Instrumentation: The instruments used for the study were as follows:

1, Hearing aid test system (FONIX 6500). This instrument has a built-in computerized program facilities for automatic testing of the hearing aids (for both coupler measurements as well as real ear measurements).

2. Microphone (M1550)
3. Standard HA-2, 2cc coupler
4. Ear level hearing aid adaptor snaps into the Yu" diameter cavity in the HA-2, 2cc coupler.
5. BTE hearing aids.
6. Shell earmold with elbow and shell earmold with CPA.

Procedure:

1. Levelling was done as soon as instrument was put on (as per Appendix-A)
2. After levelling, the BTE hearing aid with elbow earmold (Shell) was placed in position with its microphone opening at the test point and with proper acoustic connection to the coupler.
3. The correct battery voltage was provided.
4. The volume control was set to the full on position.
5. ISI button was pressed to carry out the electroacoustic characteristics of the BTE hearing aid.
6. The device was made to run through the entire program, the results were displayed on the video monitor.
7. The following parameters were considered.

a) Max. OSPL 90

b) HFA OSPL 90

c) Max - FOG

d) HFA - FOG

e) RTG

f) RL

g) F1 (Lowest frequency)

h) F_2 (highest frequency)

i) TDH (500 Hz, 1 KHz, 2 KHz)

j) DF

k) EIN

(These parameters are defined in Appendix-B).

8. Similarly electroacoustic characteristics of BTE hearing aids were measured with earmold with elbow and CFA earmold 1.

PROCEDURE FOR REAL EAR MEASUREMENTS

In order to carry-out real ear measurements (to find out the insertion gain) the following procedure was used:

1. The probe microphone with attached tube was placed on a table surface next to the clients' earmold.
2. The probe tube next to the canal on the earmold at the bottom of the earmold was held so that the tube extended 4 to 5 mm (1/B to 3/16 inch) beyond the canal.
3. The vekro head band was placed on the client's head above the ear and the reference microphone was attached facing forward directly above the ear to be tested.
4. The body of the probe microphone was attached on the ear hanger. The hanger was being on the ear.
5. The probe tube (without the earmold or hearing aid) was placed into the client's ear until the red mark is at location of the outer surface the earmold when it is in place.
6. The hearing aid was then placed in position ie. BTE. A warble tone was presented in a sweep sequence over all test frequency (250 Hz - 8KHz). At first the frequency response of the hearing aid using the CFA was recorded. And then the frequency response using elbow(The volume of the hearing aid was adjusted by the patient to his most comfortable level).

RESULTS AND DISCUSSION

Results were analyzed using ' t' test: (as shown in Table-I and II).None of the electroacoustic parameters of means of these samples were significantly different at 0.05 level.

These results suggest that there is no significant difference between electroacoustic characteristics of BTE hearing aids using CFA earmold and earmold with elbow in coupler.

Results and Discussion for real ear measurements:

By looking at the Table-I and II we can say there is no significant difference between the gain of the BTE hearing aid using earmold with elbow and earmold with CFA.

We can say that the CFA earmold extends the high frequency amplification but the gain is equal to gain of the BTE using elbow.

Mynders (1983) reported that the CFA earmold extends the high frequency amplification but be compared his results with earmold made with standard 13 tubing.

Balaraju (1992) reported that BTE hearing aid with indigenous connector with tubing earmold gives gain upto 4 KHz earmold with quill bent gives the gain upto 6 KHz whereas CFA earmold gives gain upto 8 KHz.

Table-I: showing 't' value comparing the CFA and elbow

Variables	't' scores	Probability
1-14	- 1.001	0.34
2-15	1.07	.31
3-16	- .308	.76
4-17	- .18	.85
5-18	- 0.001	.99
6-19	- .128	.90
7-20	- .58	.57
3-21	1.64	.13
9-22	.56	.61
10-23	1.15	. 27
11-24	1.27	.23
12-25	26	.78
13-26	.54	.60
27-28	.14	.88
29-30	- .508	.62
31-32	.428	.67
33-34	.044	.96
35-36	.099	.92
37-38	.949	.36
39-40	.803	.49
41-42	- .706	.49
43-44	- .204	.84
45-46	- .133	.89

Table-II :Showing representing the mean and standard deviation

Variable	Count	Statistical Summary- Mean	Std.Deviation	Minimum	Maximum
Cl	10	126.13	2.297366	123	129.2
C2	10	125.63	18.91842	117.5	179.4
C3	10	45.87	6.528068	36.2	56.2
C4	10	48.7	5.487764	38.8	56.2
C5	10	40.38	2.509006	37.1	45.9
C6	10	83.08	4.711169	79.5	95.3
C7	10	269	112.7248	200	507
C8	10	5780	1568.297	4000	8000
C9	5	9.4	8.502646	1	22.7
C1O	10	5.54	12.77734	.4	41.8
C11	10	12.8	25.81378	.3	85.6
C12	10	2.11	.9314863	.9	3.6
C13	10	39.04	16.31756	22.4	73.1
C14	10	236.22	348.6061	117.4	1228.3
C15	10	119.33	2.806758	113.8	122.7
C16	10	46.89	6.87628	36.6	57.7
C17	10	49.33	6.843334	39	57.9
C18	10	40.4	4.825856	32.6	48.3
C19	10	82.77	5.118604	78	95.7
C20	10	295.4	122.9518	200	508
C21	10	5040	1202.035	3400	8000
C22	6	3.966667	2.347481	1.4	7.4
C23	10	1.03	.5831904	.5	2.4
C24	10	2.78	2.742991	.1	8.6
C25	10	2.26	1.247 397	.7	5.1
C26	10	36.29	10.67119	23	59.5
C27	10	8.41	7.355036	.3	20.4
C28	10	7.87	10.95496	6.4	29.8
C29	10	12.67	7.93292	.4	22.9
C30	10	13.66	8.54871	1.9	27.8
C31	10	28.79	9.108781	14.7	41.8
C32	10	27.71	11.83277	-.6	42.4
G33	10	26.39	6.846321	16.5	39.6
C34	10	26.3	5.310158	18.1	34.8
C35	10	20.16	9.552219	6.1	36
C36	10	19.92	7.69 3547	8.7	34.7
C37	10	17.66	11.01849	5.4	40
C38	10	15.07	10.27608	3.5	35.8
C39	10	.03	13.53504	-17.2	23.3
C40	10	-3.389	9.709565	-22.9	14.4
C41	10	-7.74	9.206544	-19.7	14.2
C42	10	-4.73	19.49849	-38.4	21.5
C43	10	-10.78	14.31563	-31.3	10.4
C44	10	-9.87	13.23959	-28.5	10
C45	10	-5.27	14.59216	-31.4	22.2
C46	10	-4.56	15.07302	-22.2	21.5

CONCLUSION

A limitation of coupler gain, which **has** been reported consistently in the literature, is that it does not adequately express the real ear gain of the hearing aid (Hawkins and Haskell, 1982/ Pascoe, 1975; Tonnison,1975. Wetzel and Harford, 1983), Real ear probe tube assessment provides useful information regarding size and shape of acoustic signals at the eardrum. Real ear probe tube measurements is the best tool in ferreting the problem present in the response curves of a hearing aid. However, these results showed that CFa earmold extends high frequency amplification which supports Mynders (1983-84) studies.

We need to conduct more studies using CFA earmold of varying diameters by real ear probe tube method to come to a conclusion that CFA extends high frequency amplification. We cannot compare and contrast these results with any of the studies as there is no empirical studies done using CFA earmolds. This is the first study done in India using earmold with CFA and earmold with elbow.

To conclude it is also necessary to have a subjective evaluation done with subjects using the BTE hearing aid along with CFA,

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APPENDIX-A

Levelling Procedure

1. With the speaker, the reference microphone and probe tube in position push the level button on the remote control.

2. A composite tone at 69 dB SPL will sound from the speaker. Depending on the Instrument location and the ambient noise one of three different levelling conditions will result.

3) If levelling Is achieved within 2 dB in the frequencies between 600 and 5000 Hz the word levelled appears on the screen in the top box under the title current status. The measured response curve appears in the lower graph.

b) If the RMS amplitude of the reference microphone is not within 6 dB of the target the screen will show the word unlevelled.

There are several things we can try. First see if the speaker is too close or too for away from the reference microphone check to see If the microphones are unplugged. Check the caliberation of the sound field speaker and the microphones. Push the level button several times. If still unsuccessful it may be necessary to change or correct the sound field environment before trying the level again.

c) If levelling was attempted and neither levelled nor unlevelled appears in the message area it means that the present levelling compensation was somewhere between the conditions described in a and b above. Probe testing may continue if you judge that the displayed curve is within acceptable limits or you can change the sound field condition and push (level) once more.