EVALUATION OF INDIGENOUS HORN MOLDS

Reg NO M 9113

An independent project submitted as part fulfilment for the first year MSc (Speech and Hearing) to the University of Mysore

All India Institute of Speech and Hearing
MYSORE - 570 006
MAY 1992

TO:

BAM, MA. DADA. SHYAMAL, AMAL. LAXMI

Who have given* me *an affectionate world, one can ever think of and who have been backbone of my success

CERTIFICATE

This is to certify that the Project entitled **"EVALUATION OF INDIGENOUS HORN MOLDS"** *is a bonafide wort, done in part fulfilment for the First year Degree of Master of Science {Speech and Hearing) , of the student with* **Reg.No. M 9113**

MYSORE
HAY 1992

DIRECTOR
All India Institute of Speech and Hearing
MYSORE - 6

CERTIFICATE

This is to certify that this independent Project entitled **"EVALUATIOH OF INDIGENOUS HOSH MOLDS"** *has teen prepared under my supervision and guidance.*

MYSORE
MAY 1992

Dr.(MISS).S.NIKAM
GUIDE

DECLARATION

Thereby declare thatthis Independent Project entitled' **"EVALUATION OF INDIGENOUS HORN MOLDS"** *is the result of my own study under the guidance of* **Dr.(MISS).S NIKAM,** *Professor and Head of the Department of Audio logy, All India Institute of Speech and Hearing, Mysore, has not been submitted earlier at any University for any other Diploma or Degree.*

MYSORE **Reg.No. M.9113**
MAY 1992

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INTRODUCTION

In this present world the science of audiology has made tremendous and remarkable progress in the field of rehabilitation for the deaf. The modification of the hearing aids and its accesories have also progressed further ahead in order to provide an efficacious amplification to the hearing impaired population. An earmold is a plastic insert which links acoustically the hearing aid and the ear.

Till today following functions of any earmold have been found:

1) It forms a link between the hearing aid and the patient's ear.
2) It is mechanically and acoustically designed to deliver the amplified signal with controlled modifications.
3) It serves to anchor the ear level hearing aids.
4) The ear mold has a very significant influence on the frequency response of a hearing aid.
5) It provides acoustic seal to prevent auditory feedback.
6} The quality of fit often determines the usable gain of the hearing aid.

Among these the main function of ear mold is the changes of the acoustic characteristics of any hearing aid. The performance of a hearing aid on a person can be altered by changing the pathways which carries the sound from the hearing aid to the ear. These changes are called acoustic modification of the hearing aids.

Acoustic modifications are particularly useful for obtaining satisfactory fitting of hearing aids to hearing losses which are difficult to fit from the range of hearing aid responses currently available.

If we consider the spectrum of our speech and compare the hearing acuity and sensitivity throughout the speech frequency. We find relative importance mostly at high frequencies as shown in graph-I.

But as it is seen since several decades the achievement of the optimal fitting hearing aids/coupling system has been a goal for persons with impaired hearing. The search for the important electroacoustic parameters is apparent in hearing aids literature. Considerable interest had been generated during 1970's regarding two major issues 1) The width and (2) the smoothness of a frequency response. During the 1980's development of hearing aid receivers and earmold designs have generated this interest because they propose extending the high frequency range of aids as well as smoothing possibly deleterious resonant frequencies.

The most widely known development referred to as the "earmold plumbing" approachs which vary in high frequency range provide, slope of frequency response and the characteristics of frequency response smoothness, either completely smooth or with a peak arround 2.7KHz. The purpose of the 2.7KHz is to compensate for the loss of ear canal resonance due to ear mold occlusion. Libby advocated this arrangement with as wide a frequency response as possible to provide. What he described as a "transparent hearing aid response". Libby suggested that the goal of a hearing aid fitting should be to enable listeners to achieve maximum speech intelligibility and natural sound quality, so that they are not aware of wearing the aid until it is removed.

In the Graph-II below it can be find out that the several modifications of ear mold how have control over a certain frequency range. Where horns have direct control over high frequency range which is most responsible for speech intelligibility.

A Vent is the opening from the surface of an ear mold to its sound input channel, which is an intentionally produced leak (Langford, 1975).

Acoustic damper or resistor added to transmission system has the effect of smoothing the response peaks that are generated in the receiver earmold system (Katz, 1985).

Horn is a tube of varying cross section having different terminal areas that provide a change of acoustic impedance (Brunved 1985).

At present almost 90 options of earmolds are available for the acoustic modification under these 3 main headings i.e., vent, Damper and Horn (Mynders, 1986).

But according to Killion (1980) the following types of Horns are available with various manufacturers.

6R12 Earmold - has a high frequency cutoff at 6KHz. Frequency response curve rises approximately 12dB between 1000 to 6000Hz. 'R' stands for "Rising Response".

8CR earmold - has high frequency cutoff at 8KH2. The designation "CR" refers to "Canal Resonance" compensation wavelength resonance occur at 2700Hz to compensate the loss of external ear resonance.

6AM earmold - has got high cut off frequency at 6KHz. This earmold is vented to achieve a low frequency roll-off-effect (acoustic modification, AM) in addition to the improved acoustic transformation of high frequency energy.

6BC series earmolds - use the horn effect and the reverse horn effect to produce upto a l0dB high frequency boost, (thus the designation "B" or a lOdB high frequency cut (c) below the 6KHz cut of point.

16 KLT earmold - is constructed to allow a smoothly rising response upto the 16KHz cut off point. "LT" indicates this earmold is a "long tube" version of an in-the-ear aid that has been developed by Halperin et al (1977) for patients with profound SN losses below 8KHz.

6EF earmold (Killion 1981b) - This earmold was designed to work especially well with the knowles EF receiver. In addition to the basic dual tubing arrangement, the 3mm final section allows the insertion of lengths of smaller inside diameter tubing to control the high frequency response. Libby (1981) found that while excellent acoustical results were obtained using the Killion 8CR earmold, some practical problems arose. These were accumulation of moisture in the tubing (possibly because of the dampers there), cosmetic objections of the multiple tubings required, the difficulty of joining the tubings with accurate dimensioning and the difficulty of replacing the tubing assembly. To overcome these problems Libby had an earmold tube molded in one piece that was generally similar to the 8CR. These composite tube was labeled the 4mm Libby horn. The tube is used without internal dampers the smoothing of response being accomplished bya damper, typically 1500ohm, placed at the end of the earhook for OTE aids. An audiologic study of the performance of the device was reported by Davenport and Wylde (1982).

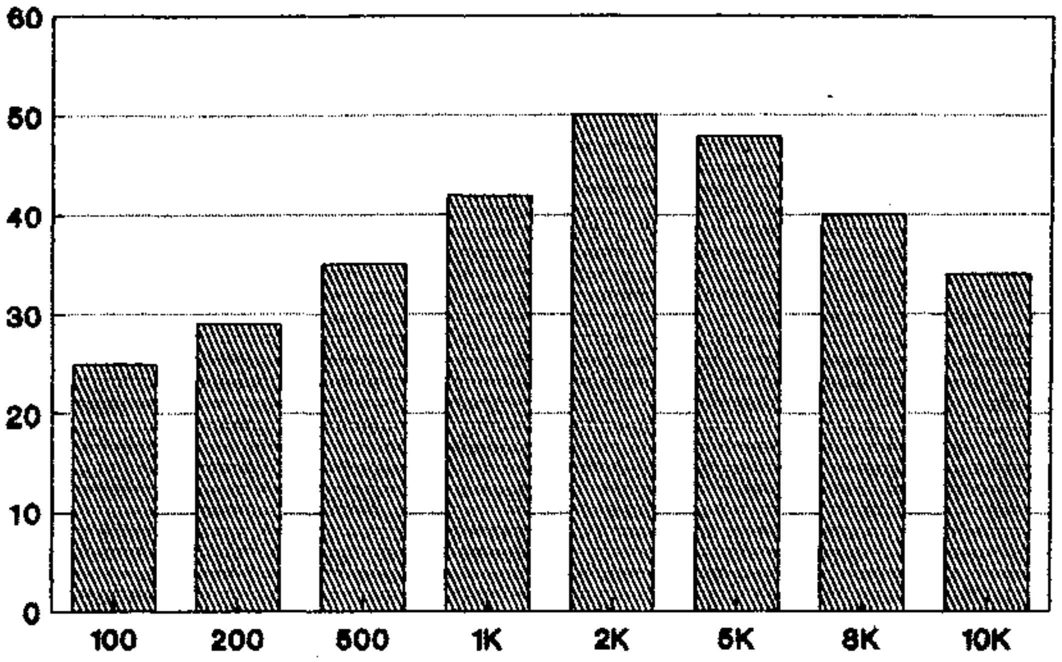
Libby has also made commercially available what is essentially the Killion 6EF dual tubing earmold as a single molded piece. This device labeled as 3mm Libby horn.

There are some studies which compare 3mm and 4mm Libby horns and each of them with regular mold without horn tube. But there is no study on indigenously made horn.

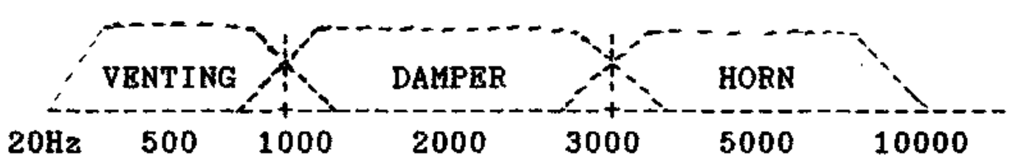
PURPOSE OF THE STUDY :

1) To evaluate the efficacy of indigenous 3mm and 4mm horns over the regular mold with Indian connector,
2) To compare the frequency characteristics of 3mm and 4mm indigenous horns.

GRAPH-I SHOWS RELATIVE IMPORTANCE OF INDIVIDUAL FREQ. BANDS FOR THE SPEECH INTELLIGIBILITY (AFTER ANSI-S-3.5 1969)



GRAPH-II SHOWS HOW VARIOUS MODIFICATIONS OF EARMOLDS HAVE CONTROL OVER DIFFERENT SPEECH FREQUENCY RANGE



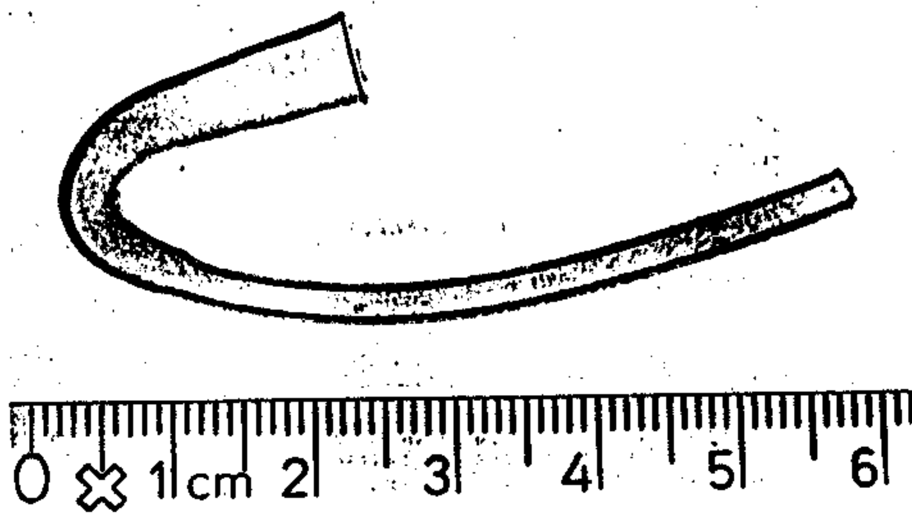
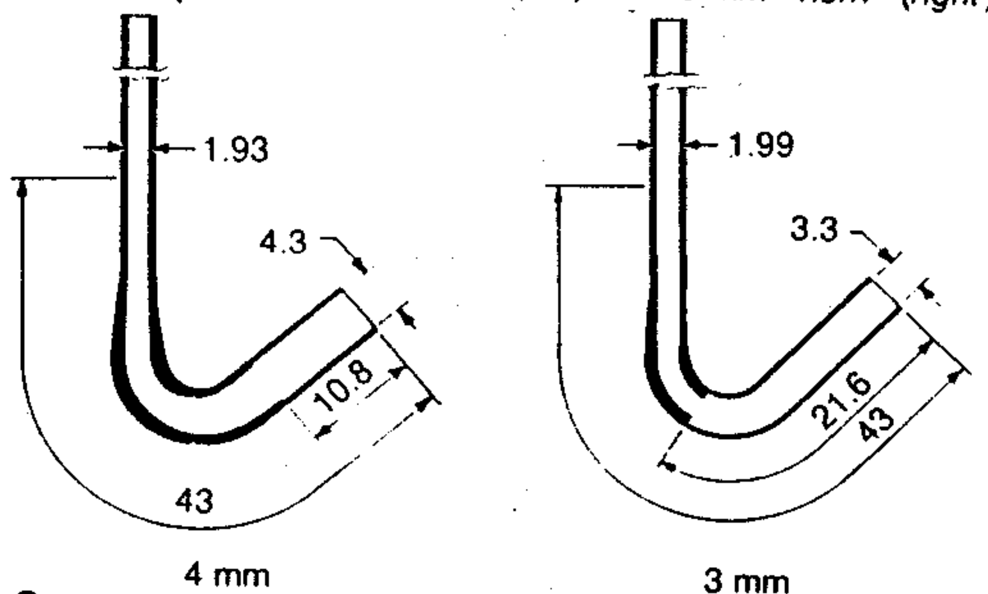


Fig. 1. The 'Libby'-type horn employed in this study.

Fig-II Libby 4-mm horn (*left*) and 3-mm "horn" (*right*)



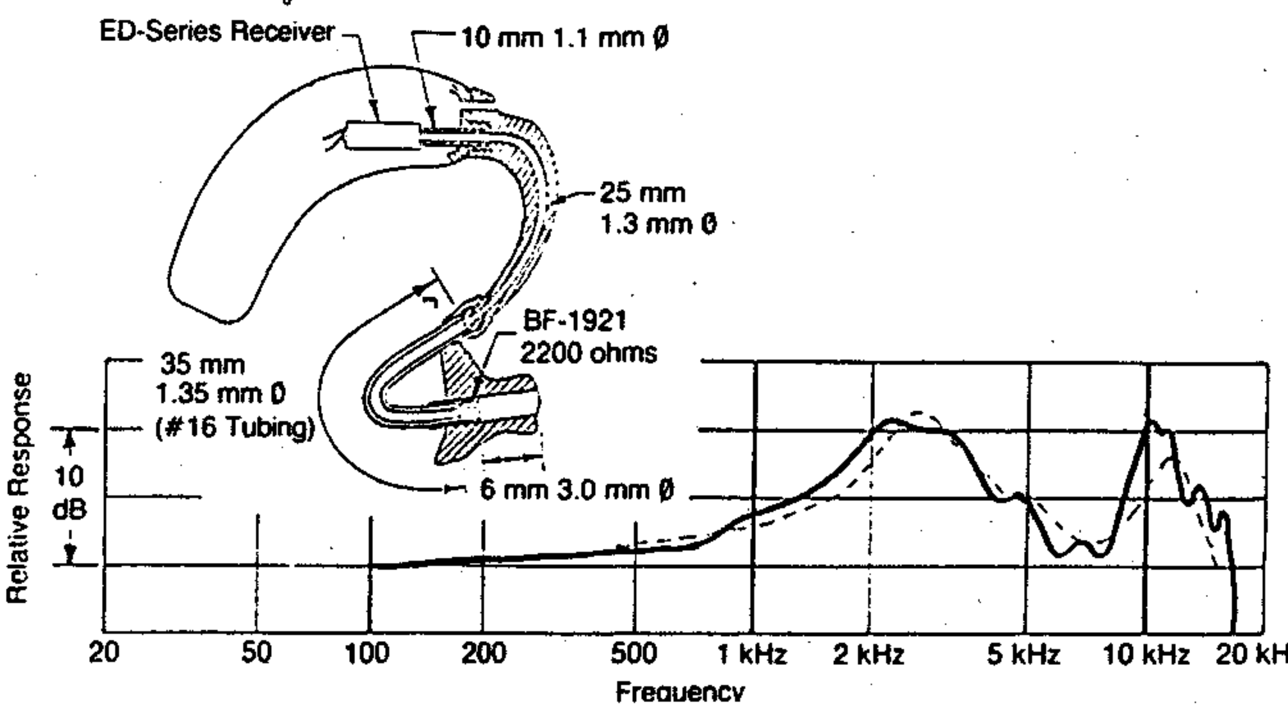


Figure III . Killion 16KLT earmold and hearing aid response. (Reproduced by permission Knowles Electronics, Inc., Franklin Park, IL.)

REVIEW OF LITERATURE

It is clear that some patients with a moderate to severe relatively flat SN hearing loss can be benefited greatly in practical life situations from extra high frequency amplification i.e., in the range 2000 to 6000Hz. This was supported by Harford and Fox (1968) in their study "The use of high pass amplification for broad frequency SN hearing loss". They also concluded that it is feasible and probably beneficial to use an unoccluding acoustic coupling in conjunction with high pass amplifier for such cases. And they believed that patients with a moderate SN loss generally use gain from a hearing aid which is approximately one half of the degree of their loss i.e., a 50dB HL requires about 25 dB gain. The average loss and gain should be computed in the range 2000 to 6OOOH2 or 1000 to 4000Hz.

As Lybarger (1972) proposed to have controlled earmold acoustic, knowles and Killon (1978) discussed the need for high frequency earmolds in conjuction with wideband receiver. Libby (1981) gives an historical review of the concept and terminology of earmold fitting and relates this to the high fidelity concept of the body, presence and brilliance. Mynders made a similar review and included resonator type earmolds. Finally Killon (1981b) reviews his earmold design and the acoustic principles employed.

Floyd (1981) conducted a study taking 8CR Killion and 6R12 molds and found that maximum gain was at 2KHz perhaps ranging from 1.5KHz to 3KHz.

In 1981 **National Association of Earmold Laboratories** (NAEL) defined horn mold as a modification of sound transmission line where the diameter at the tip of the earmold is larger than the diameter of the tubing adjacent to the earhook. They further compared the acoustic gain of Libby horn with a standard occluded earmold, Libby horn tube with freefield or CROS ear mold, modified Libby horn tube for acoustic modifier earmold. By introducing the damper to the tube they found different results. **So Libby horn was defined as simply a tube. One continuous undamped tube that produces horn effect.** They also have compared Libby horn with the resonator. They concluded that the Libby horn and the resonator has almost the same acoustic effects but those underlying principles are different.

In 1982, the Toyen Hearing center Oslo NOrway a Private Hearing Aid Clinic has fitted hearing aids with earmolds, having different horn bores (ie., Libby horn, Bakke horn, horn with ring and adapter, bellhorn and open mold with Bakke horn fitted to the end of the tube). After a hand work of couple of specialists they concluded that different types of horn bores in this study prove to be a good solution to improve their discrimination scores in background noise.

Another study by P.E.Lyregard (1982) has shown improvement in horn effect at high frequency taking 2mm diameter plumbing. He concluded that the angle piece occasionally incorporated into earmolds for attaching the tubing represents a constriction of the acoustical pathway resulting in a loss of gain amounting to approximately 4dB in the frequency region of 2 to 4KHz. And there is potentially l0dB more gain to be obtained at high frequency with only simple mechanical modifications of the earmold plumbing. The conclusion also indicated that different types of horns have in this study proved to be a good solution to improve their discrimination scores in background noise.

Surr, Cherr and Barbara (1984) maintioned that open mold with 3mm Libby horn provided similar enhancement of high frequencies to the acoustic modifier and the Janssen tube. The 3mm version was notably more acceptable to the patients than that with the 4mm reported on earlier by Mueller et al (1983). In addition, indicating greater comfort, subjects rated 3mm Libby horn more favorably for most of the attributes on speech perception in comparison to the acoustic modifier and Janssen tube fittings. Individual differences were substantial, however and no single earmold appeared to be universally best. Flexibility and continued efforts are needed to achieve the optimal fitting for individual patient.

In 1985, Harvey and Dillon experimented on earmold and high frequency response modification. He took 6B10 Killion horn and 6B0 Killion horn and found that as the canal volume is increased, the horn effect becomes greater i.e., for adult the effect of horn is more than children. In other words we may also say that the effect of earmold variation differed significantly from person to person.

The effect of an earmold variation doesnot depend significantly upon which hearing aid it is coupled to. While looking for a solution for high frequency hearing loss, Gautheir (1985) invented the Helix aid (a kind of ITE) but it was more difficult to control feedback because of close proximity of mic and earcanal so acoustic horn at the tip of the sound tube was suggested and benefit was seen as follows. Firstly it has in built damping which removes peak allows more overall gain before feedback. Secondly, and the primary purpose of the acoustic horn, it extends the high frequency response of the receiver. Finally the acoustic horn provides a significant boost of frequencies in the speech bands. By incorporating the acoustic horn and keeping the sound tube as long as practical, useful gains of upto 35dB have been achieved. Since many individuals with this type of impairment show evidence of recruitment, soft diode clipping is employed to limit outputs (typically in the range of 96dB average SSPL 90).

In 1991 Burgess and Brooks studied on earmold and found some benefits from horn fitting. They found the narrow bore of conventional hearing aid earmolds restricts the transmission of higher auditory frequencies. For subjects with moderate to severe high frequency hearing loss this is likely to have an adverse effect on the perception and recognition of phonemes with high frequency components. Twenty two subjects with predominantly high frequency hearing loss underwent a series of tests to compare the performance of earmolds fitted with a smooth horn having a final internal diameter of 4mm. The test battery comprised of freefield Bekesy audiometry, in the ear pressure measurement speech audiometry using AB word lists and semantic differential ratings of the relative sound quality of the two systems. Subjectively the horn fitting was rated as clearer, more natural, undistorted and acoustically comfortable. Objectively by both Bekesy audiometry and in the ear pressure measurement the horn gave gain in the higher auditory frequencies. With horn there was improved recognition of phonemes, especially of fricatives and affricates.

Bergenstoff (1983) conducted one study where he measured real ear insertion gain of a normal behind-the-ear hearing aid with earmold consists of Libby horn. The frequency range is extended almost one octave, and the level of the high frequencies are increased by 10 to 15 dB. While the masking resonance in the midfrequency range is reduced by approximately 4dB.

When an ear mold with Libby horn is used in connection with a wide range of behind-the-ear hearing aids,the frequency range extended by almost two octaves and the level of high frequencies are increased by approximately 20dB. While the masking resonance in the midfrequency range is reduced by 8 to 10dB.

He also found that Libby horn provided considerable acoustical improvement but some dificulties in practical usage have been reported as follows.

1) As the tube, horn and the earmold form an integrated unit, the tube reportedly is difficult to exchange.
2) The ear mold is rather difficult to manufacture, because it is hard to find room for the horn in the tip of the earmold unless the tip of the earmold is cut away.

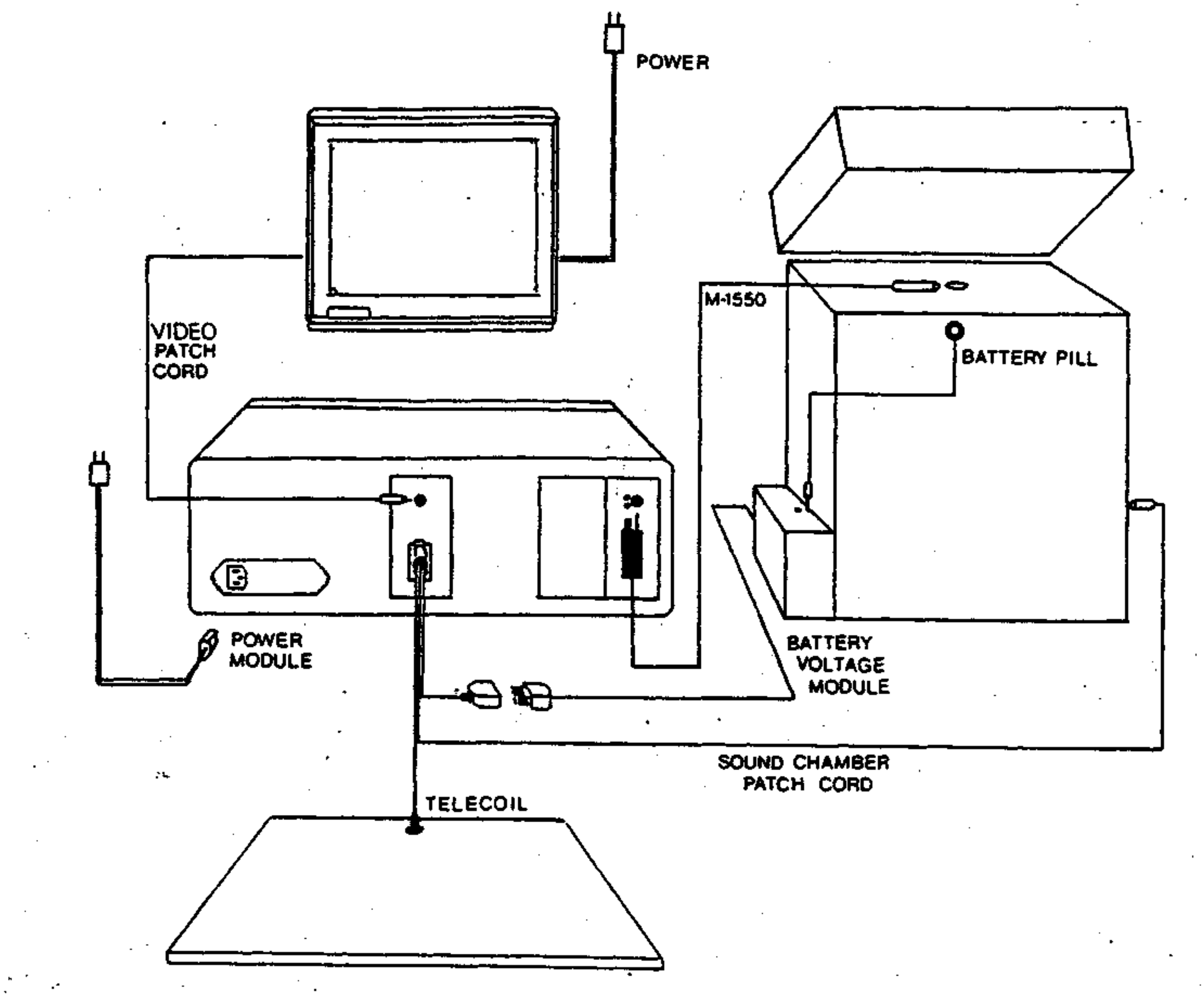


Fig-IV Fonix -6500

METHODOLOGY

SELECTION OF HEARING AID;

A total fourteen behind-the-ear hearing aids had been selected, which had facilities of normal (N) position in the tone control. But four of them showed problem in tone control switch, volume control switch and had irregular output during examination. So they were excluded from the study. Out of ten haring aid, some of which were regularly used in Hearing Aid Trial (HAT) for testing the patients and the rest were used by patients who were attending therapy at Speech and Hearing clinic. Hearing aids were of different models and gain.

SELECTION OF EARMOLD

The earmolds (Regular earmold with indian connector, 3mm horn, 4mm horn) were prepared at Speech and Hearing Lab by taking impression from a patient with high frequency hearing loss.

TEST ENVIRONMENT

Test was carried out in an air conditioned and sound treated room. The ambient noise level inside the room was with in permissible level (ISI - 0776- 1984).

INSTRUMENTATION

The instruments used for the study were as follows:

1) Hearing aid electroacoustic performance test system (Fonix-6500).

2) 1" microphone (B&K Ml550)
3) 2CC coupler (B&K HA-2)
4) Different sizes of molds i.e., Regular mold with indian connector, indigenous 3mm horn,indigenous 4mm horn.
5) BTE hearing aids 10 number.

PROCEDURE

1) The instrument (Fonix 6500) was switched on and allowed to worm up for 10 min.
2) Keeping the mic at the reference point the switch was pressed for leveling.
3) As soon as the instrument was leveled the Regular mold with indian connector (RM with IC) was connected with mic by means of 2CC coupler. Molder-clay was used for proper connection.
4) Receiver of the hearing aid was kept on the reference point and keeping the hearing aid volume in full-on-position, lid was closed.
5) Start switch was pressed, followed by reset switch.
6) There was common switch to start and chosing the standard. So ISI written switch was pressed.
7) Current and battery voltage was provided by buttery pill.
8) After following all the commands displayed the results were displayed on the video screen.
9) Same procedure was followed to measure parameters for the 3mm and 4mm horns.
10) Following parameters were noted.

a) Maximum OSPL 90

b) HFA OSPL 90

c) High frequency average full on gain (HFA FOG)

d) Refference test gain (RTG)

e) 500Hz Harmonic Distortion (HD)

f) l000Hz H.D.

g) 1.6KHz H.d.

h) D.F. distortion at 1KHz (%)

i) Equipment input noise level (BIN).

j) Current drain

k) Response limit (RSP Lt.) (dB)

1) Fl (Lower limit of frequency response)

m) F2 (higher limit of requency response)

n) Dse gain (UG)

Above parameters are defined in Appendix-II.

Table-I: Showing Results of Electroacoastic paameters of N.A measurment and the statistics

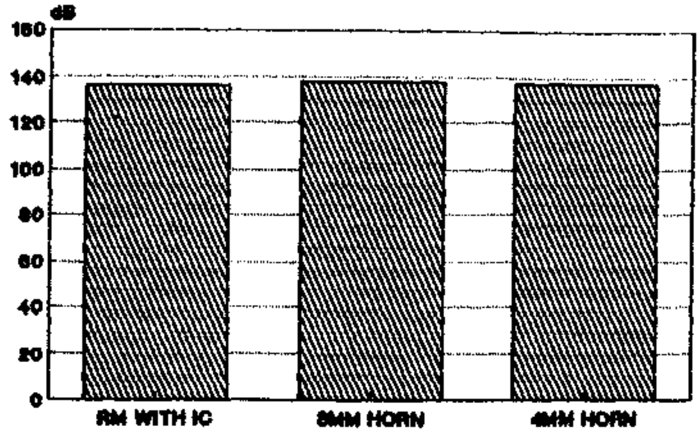
		Max. QSP190 (dB)	HFA OSPL 90 (dB)	*EFA* 0F6 (dB)	BTG (dB)	HARMONIC DISTORTION SOOlz (%)	lOOOlz (%)	16001s (%)	DF Dist. at 1KHz (%)	EIN	Current Drain (HA)	RSP Lt. (dB)	Fl (Hz)	F2 (Hz)	BG (dB)
Regular mold with Indian connector	Mean	136.26	127.36	53.27	49.73	8.13	1.37	0.43	3.28	34.09	2.42	89.11	265.70	4860	23.15
	S.D.	3.377	3.806	7.924	4.164	12.942	0.781	0.462	2.089	9.109	1.74	4.02	88.49	656.92	13.10
3MM Libby born	Bean	138.26	129.63	55.01	51.07	12.5	1.52	0.466	6.10	32.06	2.34	92.92	272.50	5090	25.05
	S.B.	3.556	4.007	7.47	4.945	16.034	0.872	0.570	6.298	8.096	1.48	5.74	86.02	634.99	11.96
4MM Libby horn	mean	137.55	129.49	54.94	51.27	12.36	1.21	0.556	4.68	33.23	2.39	89.92	282.00	5480	29.75
	5.D.	3.699	4.093	7.038	4.180	12.214	0.767	0.751	3.029	7.798	1.65	4.29	106.02	1076.82	11.04
ANOVA*		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
F RATIO		0,8147	1.03	0.173	0.355	0.208	0.344	0.1020	1.12	0.148	5.97	1.78	7.59	1.47	7.16
DF1		2	2	2	2	2	2	2	2	2	2	2	2	2	2
DF2		27	27	27	27	13	26	26	27	27	27	27	27	27	27
P Value		0.453	0.370	0.842	0.704	0.814	0.711	0.903	0.340	0.862	0.99	0.186	0.927	0.246	0.931

Note : '*' = Not Significant

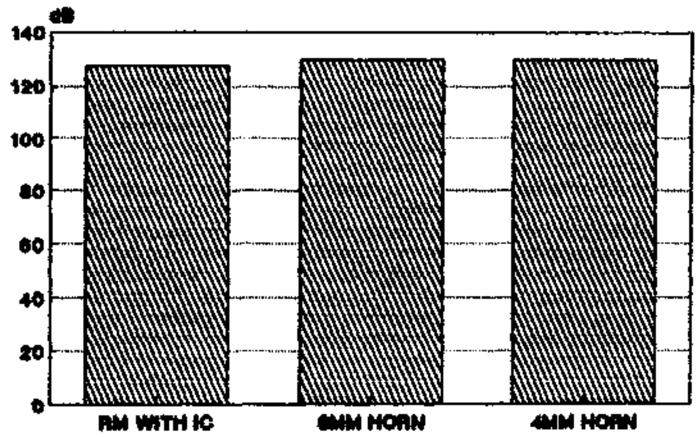
T TEST ALSO SHOWS ALL PARAMETERS ARE NOT SIGIIFICAIT

GRAPH-III

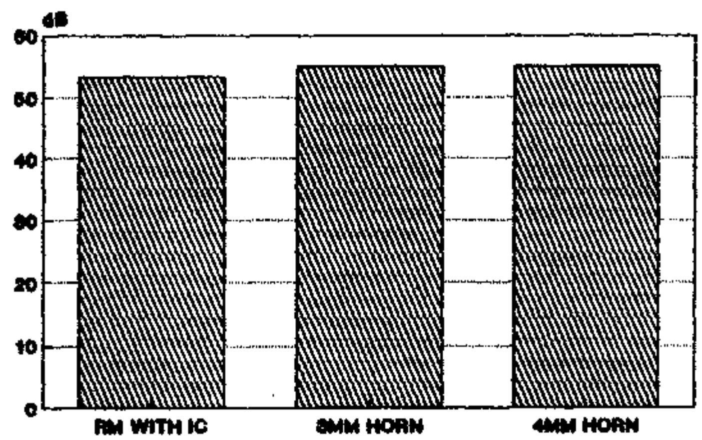
1. BAR DIAGRAM SHOWING MEAN OSPL 90 VALUES IN dB OF REGULAR MOULD WITH INDIAN CONNECTOR. 3MM & 4MM HORNS



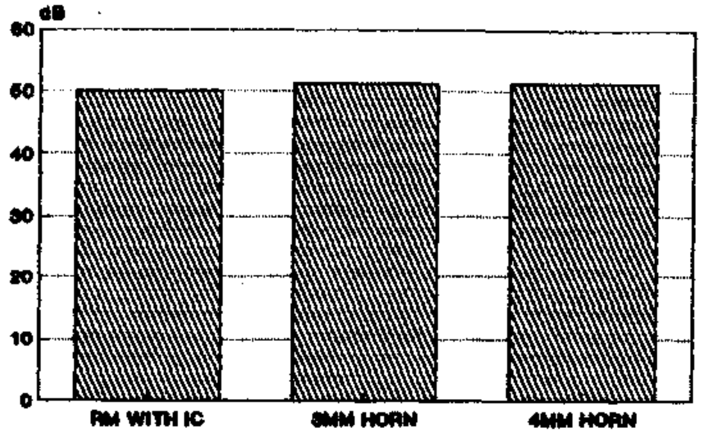
2. BAR DIAGRAM SHOWING MEAN HFA VALUES IN OB OF REGULAR MOULD WITH INDIAN CONNECTOR. 3MM & 4MM HORNS



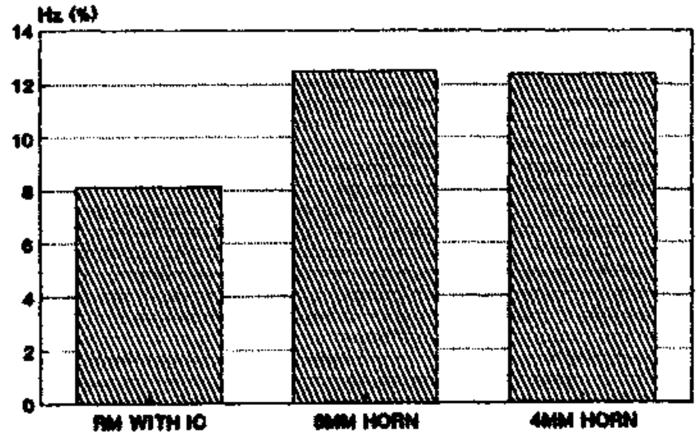
3. BAR DIAGRAM SHOWING MEAN HFA-FOG VALUES IN dB OF REGULAR MOULD WITH INDIAN CONNECTOR. 3MM & 4MM HORNS



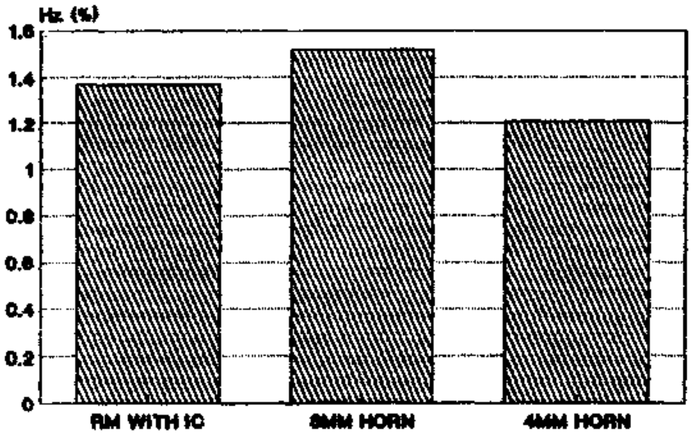
4. BAR DIAGRAM SHOWING MEAN RTG VALUES IN dB OF REGULAR MOULD WITH INDIAN CONNECTOR. 3MM & 4MM HORNS



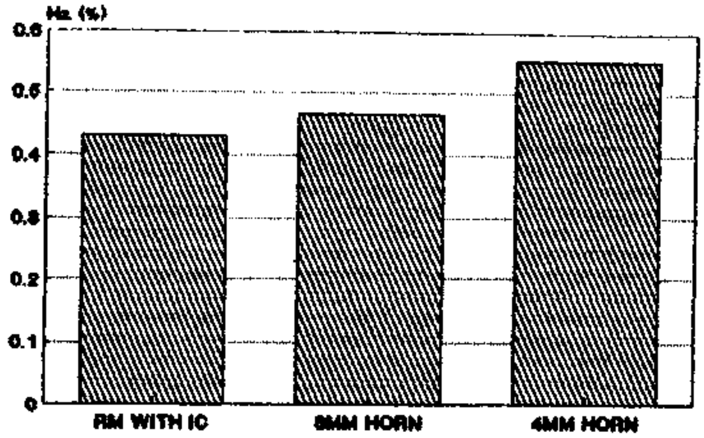
6. BAR DIAGRAM SHOWING MEAN HD VALUES AT 5OOHZ OF REGULAR MOULD WITH INDIAN CONNECTOR. 3MM & 4MM HORNS



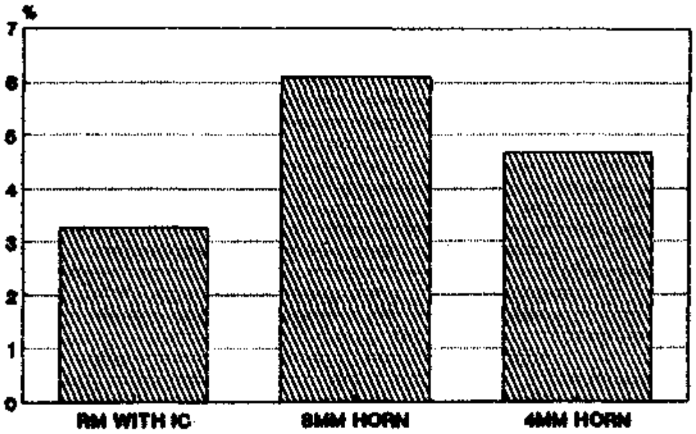
6. BAR DIAGRAM SHOWING MEAN HD VALUES AT 1KHz OF REGULAR MOULD WITH INDIAN CONNECTOR, 3MM & 4MM HORNS



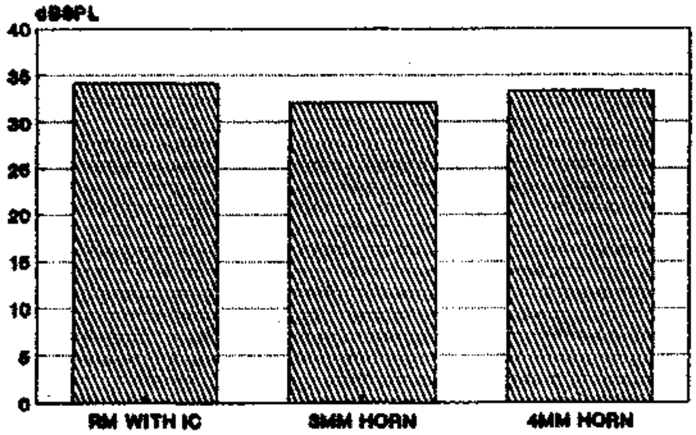
7. BAR DIAGRAM SHOWING MEAN HD VALUES
AT 1.6KHz OF REGULAR MOULD WITH
INDIAN CONNECTOR. 3MM & 4MM HORNS



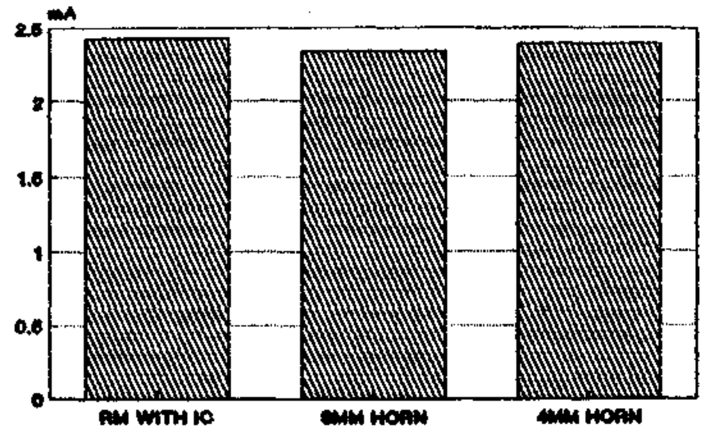
8. BAR DIAGRAM SHOWING MEAN DFD VALUES
AT 1KHz (%) OF REGULAR MOULD WITH
INDIAN CONNECTOR. 3MM & 4MM HORNS



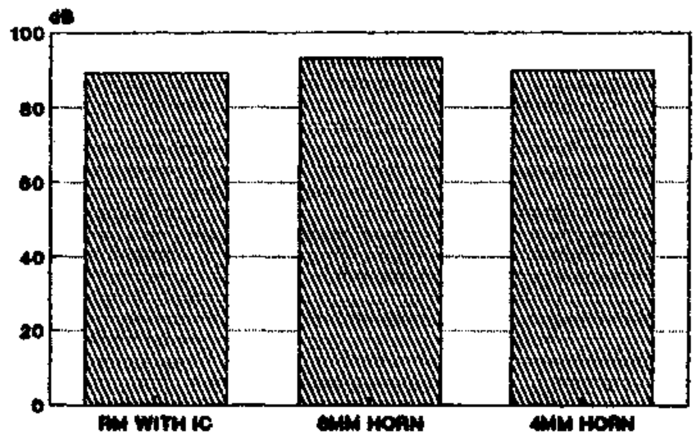
9. BAR DIAGRAM SHOWING MEAN EIN VALUES
AT 1KHz (%) OF REGULAR MOULD WITH
INDIAN CONNECTOR, 3MM & 4MM HORNS



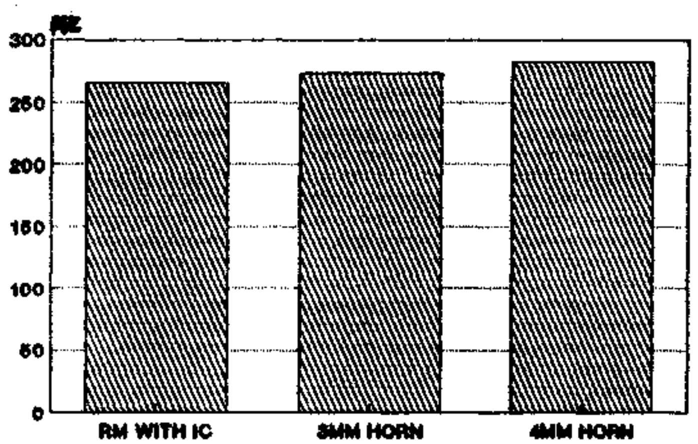
10. BAR DIAGRAM SHOWING MEAN CD VALUE IN mA OF REGULAR MOULD WITH INDIAN CONNECTOR, 3MM ft 4MM HORNS



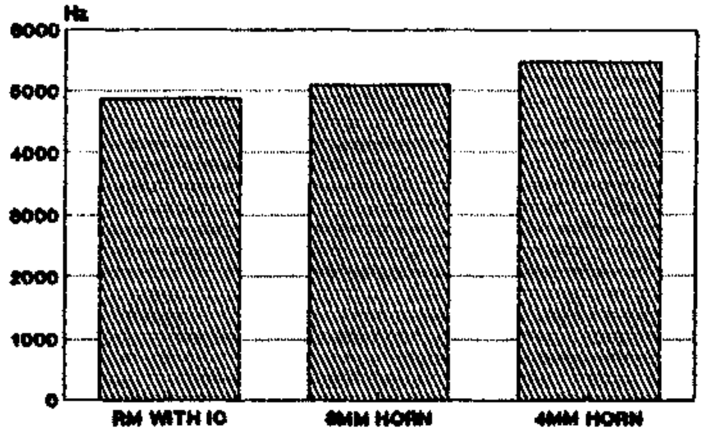
11. BAR DIAGRAM SHOWING MEAN RSP Lt VALUES IN dB OF REGULAR MOULD WITH INDIAN CONNECTOR. 3MM & 4MM HORNS



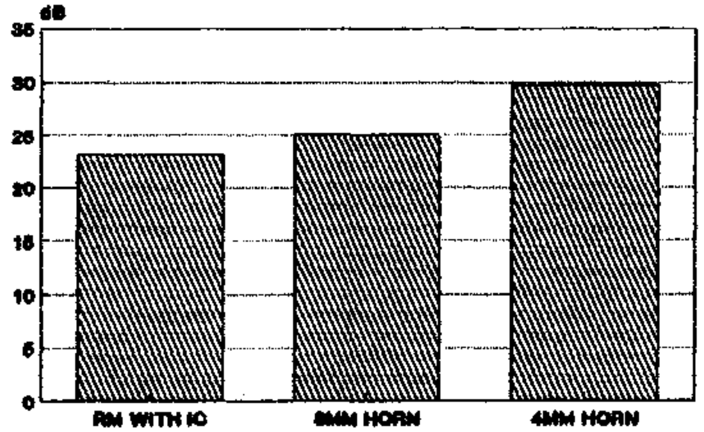
12. BAR DIAGRAM SHOWING MEAN F1 VALUES IN HZ OF REGULAR MOULD WITH INDIAN CONNECTOR. 3MM & 4MM HORNS



13. BAR DIAGRAM SHOWING MEAN F2 VALUES IN Hz OF REGULAR MOULD WITH INDIAN CONNECTOR, 3MM & 4MM HORNS



14. BAR DIAGRAM SHOWING MEAN UG VALUES IN dB OF REGULAR MOULD WITH INDIAN CONNECTOR, 3MM & 4MM HORNS



RESULTS AND DISCUSSION

As mentioned in measurement procedure, for ten hearing aids in three conditions, parameters were measured separately. For each hearing aid in each condition fourteen parameters were measured. Values displayed on the video screen were noted separately for each parameter in each condition for a single hearing aid.

But later for each parameter in each condition mean values were made by adding the ten values obtained from ten hearing aids. Simultaneously standard deviation (SD) was computed for each mean values. Mean values for each parameters in three conditions were shown graphically in Graph-III.

While comparing three mean values in three conditions for each parameters using the statistical method (one way ANOVA) it was seen in each parameter those three conditions did not differ from each other significantly by their values.

Even T test was done for these three conditions to compare each other condition values for each parameter. It also did not show any significant differences.

Along with the ANOVA results F RATIO, DF1, DF2 & P scores for each parameter shown in the table-1.

There is no significant differences between the values of three conditions, Regular mold with Indian connector, Indigenous 3mm horn and Indigenous 4mm horn for each parameter. The null hypothesis can be accepted that "there is no significant difference in the electroacoustic characteristics of the hearing aids when connected with above mentioned three types of earmolds".

However if we compare graph-III (12) and III (13), we can see the frequency range where RM with IC is more efficient, shifts to words higher frequencies for 3mm horn and for 4mm horn still higher frequencies but may not be significant as expected.

Graph-III (3, 5, 6 and 7) shows there was some amount of difference in the Harmonic distortion among the molds. The differences were more in lower frequencies but less in higher frequencies. Graph-III (8) depicts that there are some amount of DF distortion differences present among the earmolds.

It could be due to several pitfalls in the study of electroacoustic measurements as follows:

1) Number of hearing aids were very less (only ten)
2) All the hearing aids were not new, though they were used in clinical testing and some by patients we are not sure about the regularity of output.

SUMMARY AND CONCLUSION

It was first time, in Indian earmold laboratory 3mm and 4mm horn were made and to evaluate the efficacy of these two types of molds, 14 electroacoustic characteristics of the hearing aid performance were measured individually by using Regular mold with Indian connector, 3mm Horn and **4mm** Horn.

It was found overall that there was little difference in gain (SPL) relatively through the frequency range of 200Hz to 8KHz. But differences were not significant by statistical measurement .

So we can conclude that indigenous 3mm and 4mm horns are not significantly efficient to improve the speech intelligibility of a sensory neural hearing loss case.

As the test procedures had some pitfalls we can control those variables and do further study on the same to see whether really these two types of earmolds, are efficient enough to help SN hearing loss person or not.

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APPENDIX-I

A CASE STUDY

Hearing aid gain as a function of frequency experienced by the wearer, can be specified in terms of insertion gain as defined by D.Jeson (1972).

The insertion gain is the ratio of the sound pressure at a specific point in the earcanal of the treated ear to the sound pressure at the same point in the ear canal of the untreated ear. Katz 1985 has told insertion gain in the difference between aided and unaided sound-presure-level at the eardrum membrane, as picked up by a probe tube microphone.

A single case study was done to compare the insertion gain in three different earmolds (RM with IC, 3mm horn and 4mm horn) throughout the frequency range 200Hz to 8KHz.

A case of 32 years age, male with severe sensorineural hearing loss was selected for this study. The case had been considered as a candidate for hearing aid user and a BTE hearing aid had been obtained for him. By using the selective method of hearing aid prescription we found Novax spectra PP is fit for the case with maximum benefit of hearing.

Resultts obtained are as follows:

	Ear	Vol	Mode	Distant	Question	P.B.Word	Tolerance
RM+IC	Lt	2	A	5	5/5	5/5, 1R	No
3mm H	Lt	2	A	5	3/5	4/5,	No
4mm H	Lt	2	A	5	4/5	4/5, 1R	No

After finding an adequate hearing aid for the case we calculated real ear acoustic gain from sound pressure levels measured in the ear, canal (near the ear drum) with the help of a probe tube mic in unaided and aided conditions at levels well above the ambient noise.

EQUIPMENT

A probe system (Fonix 6500) was used to measure hearing aid gain using different ear molds (RM with IC, 3mm H and 4mm H).

PROCEDURE

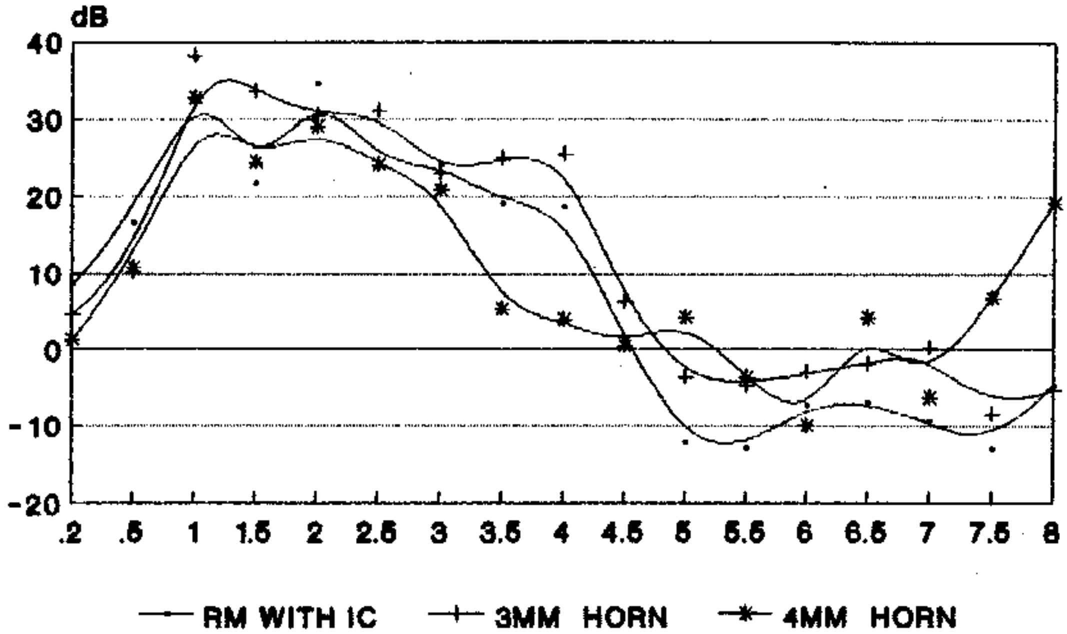
When measuring probe tube gain the subject was seated in a chair approximately 3 ft from the loud speaker of probe tube system. The frequency modulated tone from the loudspeaker was kept at a constant level of 70dB SPL in the area of patient ear as it swept through the test frequency. The soft rubber tube connected to the probe microphone was inserted into the ear canal. The signal emitted from the loudspeaker into the ear canal. The signal emitted from the loudspeaker was then measured in the earcanal and resonance curve of the external earcanal was determined displayed in the video screen.

Then the regular mold with Indian connector was connected with prescribed hearing aid. And the earmold was inserted into the earcanal along with the probe tube to the same depth of the canal. But the tube was placed in between the earcanal wall and earmold. The relative SPL to the unaided condition was then measured in the ear canal. The same procedure was used to measure insertion gain by 3mm horn and 4mm horn which are all shown in the Fig-IV(a). As it is seen there is almost with in the same frequency range 3 of the molds are efficient.

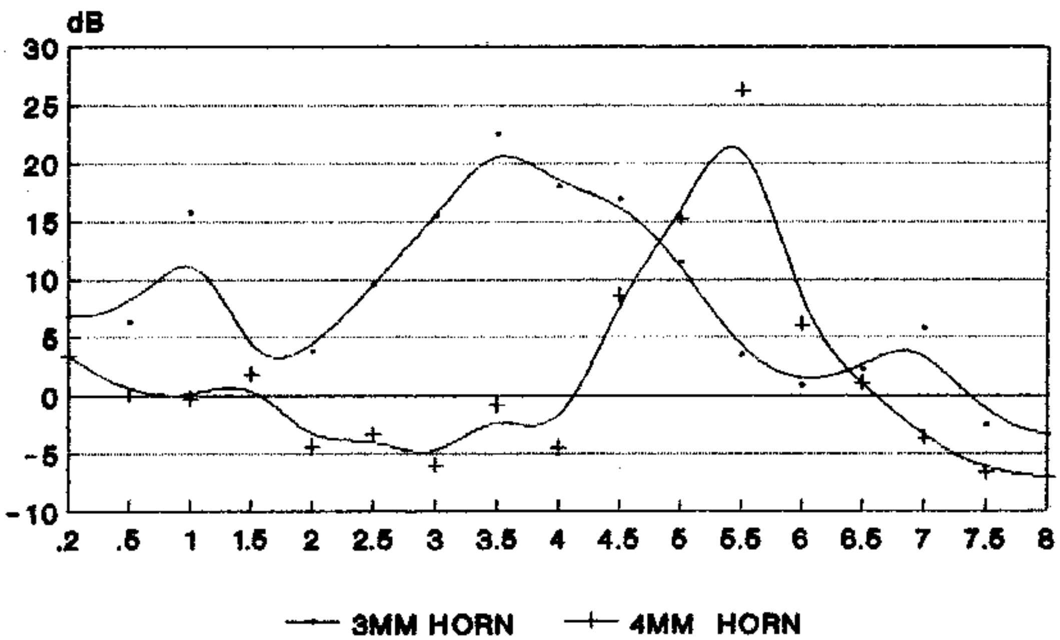
Moreover to check the acoustic gain of 3mm horn and 4mm horn over RM with IC same types, of procedure was used. Instead of unaided condition RM with IC mold aided condition was used i.e., acoustic gain was obtained comparing 2 aided conditions. Two curves for efficacy of 3mm horn and 4mm horn over RM with IC are shown in Fig-IV(b).

Seeing Fig-IV(b) while comparing 3mm horn and RM with IC max.SPL shift towards high frequency was found. For 4mm horn it is still more shifted towards high frequency. While comparing 3mm and 4 mm horn the shift towards high frequency was not significant.

IV(a).QRAPH SHOWING INSERTION GAIN AT VARIOUS FREQUENCIES IN REGULAR MOULD WITH INDIAN CONNECTOR, 3MM & 4MM HORNS



IV(b). GRAPH SHOWING ACOUSTIC GAIN AT VARIOUS FREQUENCIES IN 3MM & 4MM HORNS WITH REFERENCE TO RM WITH IC



APPENDIX II

I) SSPL 90 - Saturation sound pressure level for 90-dB input sound pressure level:

The saturation sound pressure level for a 90dB input sound pressure level is defined as the sound pressure level developed in a 2c.c. earphone coupler when the input sound pressure level at the microphone sound entrance on the hearing aid is 90dB re 20m Pa, with the gain control of the hearing aid full on.

2) **HFA SSPL 90- High frequency average saturation sound pressure level:**

The high frequency average saturation sound pressure level is defined as the average of the 1000; 1600 and 2500Hz values of SSPL 90.

3) HFA FOG - **High frequency average full on gain:**

The high frequency average full on gain is defined as the average of the 1000, 1600 and 2500Hz values of full on gain.

4) RTG - Reference test gain:

The reference test gain is defined as the gain of a hearing aid when its gain control is set to amplify a 60dB sound pressure level input the saturation sound pressure level of the hearing aid. Gain and saturation values are determined on the basis of the average of 1000, 1600 and 2500Hz values.

5) H.D. - Harmonic Distortion:

With gain control in the reference test position and with an input sound pressure level of 70dB, measure and record the total harmonic distortion in the coupler output for input frequencies of 500Hz, 1KHz, 1.6KH2.

In the event the response curve rises 12dB or more between any distortion test frequency and its second harmonic, that test frequency may be omitted.

6) EINL - Equipment input Noise level (Ln)

With the sain control in the test reference position, determine the average of the coupler sound pressure levels at 1000, 1600 and 2500Hz for an input sound pressure level of 60dB. Remove the acoustic input signal and record the sound pressure level in the couper caused by inherent noise.

7) Current Drain - With the gain control in the reference test position, measure the battery current with a pure tone l000Hz input signal at a sound pressure level of 65dB.

8) Use gain (UG): It is the gain of the hearing aid obtained by setting the volume control at 2 volume setting for the given hearing aid.