Pakistan Journal of Otolaryngology 2012; 28 : 102-104

Case Report

Use of CROS Hearing Aid in Conjunction to CIC Hearing Aid: A Case Study

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ABSTRACT: Patient aged 34 years male presented with complaint of hearing loss in the both ears. The onset of hearing loss was due to middle ear infection, underwent middle ear reconstruction surgery and was fitted with Complete In the Canal (CIC) hearing aid in the better ear. Pure tone audiometry, immitance audiometry and the speech discrimination scores revealed that the patient has moderate sensorineural hearing loss in his left ear and the severe sensorineural hearing loss in his right ear. Patient was advised and fitted with CIC hearing aids in the left ear. The puretone aided response with CIC hearing aid was close to normal levels of hearing. The speech discrimination scores were also 70% when the signal was delivered from the better ear that is left side which were lowered when the same intensity stimuli was presented through the poorer side to 30%. Clinician must continue to provide better option of amplification even the best amplification device has been provided to the cases. The amplification protocol must not end at one style of the hearing aids but it must continue considering the benefit of the amplification devices.

Key Words: Amplification, Complete In the Canal, Speech discrimination score.

INTRODUCTION: The binaural redundancy component of binaural advantage diminishes as the average hearing thresholds of the two ears become more dissimilar[1]. Speech intelligibility was found to be maximized by a bilateral fitting of amplification devices[2]. Persons, who are fitted with hearing aid in one ear with the other ear unaidable, are not uncommon and often report dissatisfaction from a hearing aid because they continue to have difficulty hearing persons who address them from the side of the "unaidable" ear. The application of an auxiliary microphone added to a standard ear level hearing aid for persons who have a significant bilateral hearing loss, but with one unaidable ear and termed it as BICROS hearing aid[3]. However, CROS hearing aids are not available even for trial purpose in most of the clinics as well as with hearing aids dealers/manufactures. Thus cases with asymmetrical/unilateral hearing loss go without amplification, adding a great deal for more handicapping than any available measures can show. Not many clinician has the scope to offer CROS hearing aid trial before prescribing CROS hearing aid or its variant[4]. Sinha (2005) reported that patient using CROS hearing aids speech discrimination improved on average when the signal was delivered from the poorer ear to 86.4 % with the CROS hearing aid from 48% for the unaided conditions. When the signal was presented from the 0 degree azimuth, the speech discrimination improved to 95 % (aided) from 72 % (unaided). The improvement in the speech discrimination can be interpreted as elimination of head shadow effect as sufficient energy is reaching the cochlea for the purpose of speech system and due to this gain is in the speech discrimination. As speech discrimination improves with the application of CROS hearing aids and the ability to locate the source of the sound also improves one may conclude that young children with unilateral hearing loss or asymmetrical hearing loss can significantly benefit from the CROS hearing aid. Completely in the canal (CIC) hearing aids are the most cosmetically appealing, miniaturized contemporary hearing aid styles. Researchers were shown that CIC produce advantage in hearing regarding reduced occlusion effect, increased hearing aid headroom, feedback reduction, improved listening in noise and security of fit, as well as normal telephone use[5]. Fitting of CIC hearing aid in the ear with moderate to moderately severe hearing loss can significantly improve the aided hearing thresholds, but may not improve directionality, speech discrimination when the sound is incident from the poorer ear. Patient having asymmetrical hearing loss with one ear unaidable and the other ear aidable, if fitted with CIC hearing aid there will be significant improvement in the hearing of the person. But the patient may continue to have poor localization, reduced speech discrimination in presence of ambient noise or when sound arrives from the poorer ear. As after amplification in one ear, the benefit converts the loss as unilateral hearing loss and thus a good candidate for the use of CROS hearing aids. There seems to be no study regarding hearing aid fitting criteria in a case with asymmetric hearing loss, using hearing aid in better ear and the benefits of the amplification resulting in candidacy for yet another style of hearing aid.

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and was fitted with CIC hearing aid in the better ear. Detail case history was taken. After the ENT evaluation, pure tone audiometry as per the standard procedure was conducted along with speech audiometry. Patient's aided puretone threshold, speech discrimination scores when fitted with CIC hearing aid in the better ear were obtained. Similar results were recorded with additional fitting of the CROS hearing aids. Patient was fitted with the CIC hearing aid in the better ear and the measurers such as aided pure tone threshold, speech discrimination scores, and localization responses were measured. These scores were compared with the scores obtained with fitting of the CROS hearing aids in addition to the CIC hearing aid. Both Tympanic membranes were found to be intact. Pure tone audiometry and the speech discrimination score for the case is shown in Table 1 and 2 respectively. Immitance audiometry revealed 'A' type and 'As' type of tympanogram in right and left ear respectively. Acoustic reflex were found to be absent. Free field pure tone aided response of the subject with CIC hearing aid in the left ear (A1), CIC hearing with CROS hearing aid with parallel tube (A2) and with tube bent towards the external auditory canal (A3) are depicted in the Table 3. Response of the case with and without CROS hearing aid to pure tone stimuli are shown in Table 4. A4 was the response with CROS hearing aid switched off and the tone was presented through the right speaker.A5 was the similar nature response except that the tone was presented through the left speaker. Speech discrimination score was 30% and 70% when the CROS was switched off and the speech stimuli was presented through right and left speaker respectively. Aided response with Modified BICROS arrangement. Response of the puretones and were obtained when the CROS hearing was fitted along with the CIC hearing aid so as to work as modified BICROS hearing aid are shown in the Table 5. Speech discrimination score when CIC was in left ear, CROS was switched on and speech stimuli presented through right ear were 70% which further enhanced up to 90% when the speech stimuli was presented through the left speaker. DISCUSSION: Generally we prescribe the hearing aid in the better ear (when the loss is asymmetrical) on the basis of pure tone thresholds. The unilateral fitting improves the performance of hearing but the directionality aspect is left unattended. The present study shows although the subject was fitted with a CIC hearing aid and had significant improved hearing but still lack the localization of the sound, reduced speech discrimination in the presence of the ambient noise. Patient also reported having balance problem which he can even feel while walking in his gait. Pure tone audiometry, immitance audiometry and the speech discrimination scores revealed that the patient has moderate sensorineural hearing loss in his

EAR	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz	PTA
Right(AC)	60dB HL	70dB HL	90dB HL (Masked)	90dBHL (Masked)	90dB HL (Masked)	110dBHL	85.3dBHL
Left(AC)	50dB HL	50dB HL	60dB HL	50dB HL	30dB HL	60dB HL	53.3dBHL
Right BC	40dB HL (Masked)	50dB HL (Masked)	70dB HL (NR)	75dB HL (NR)	80dB HL (NR)		
Left BC	30dB HL	40dB HL	50dB HL	50dB HL	25dB HL		

Table 1: Result of pure tone audiometry.

EAR	SRT	SDS
Right	85 dB HL	0%
Left	60 dB HL	100 %

Table 2: Result of Speech Audiometry.

Frequency (Hz)	Free – Field (dB SPL)	A1 (dB SPL)	A2 (dB SPL)	A3 (dB SPL)
250	50	50	45	40
500	65	65	60	55
1000	50	25	25	25
2000	60	40	35	30
4000	50	35	35	30
8000	75	65	65	65

Table 3: Free field aided response of the subject with CIC hearing aid in the left ear (A1), CIC hearing with CROS hearing aid with parallel tube (A2) and with tube bent towards the external auditory canal (A3)

Frequency (Hz)	A4 (tone through right speaker when CROS is switched off)	A5 (tone through left speaker when CROS is switched off)
250	45 dB SPL	30 dB SPL
500	45 dB SPL	30 dB SPL
1000	60 dB SPL	30 dB SPL
2000	50 dB SPL	35 dB SPL
4000	60 dB SPL	30 dB SPL
8000	70 dB SPL	50 dB SPL

Table 4: Response of the case with and without CROS hearing aid to pure tone stimuli Speech discrimination score was 30% and 70% when the CROS was switched off and the speech stimuli was presented through right and left speaker respectively.

Frequency (Hz)	A6 (tone through right speaker when CROS was switched on)	A7 (tone through left speaker when CROS was switched on)
250	40 dB SPL	35 dB SPL
500	55 dB SPL	40 dB SPL
1000	35 dB SPL	30 dB SPL
2000	40 dB SPL	35 dB SPL
4000	45 dB SPL	45 dB SPL
8000	65 dB SPL	55 dB SPL

Table 5: Aided Pure Tone response with Modified BICROS Speech discrimination score when CIC was in left ear, CROS was switched on and speech stimuli presented through right ear were 70% which further enhanced up to 90% when the speech stimuli was presented through the left speaker.

which were lowered when the same intensity stimuli was presented through the poorer side to 30%. Thus, in spite of using the beat amplification device the patient's capacity of better commutation skill is not optimized. As the CIC in left ear almost brings the hearing level in the left to near normal, with the amplification on patient can be considered as case with unilateral hearing loss, with left ear near normal hearing (after using CIC hearing aid) and the other ear was unaidable (Speech discrimination score 0%). As per Hardford and Barry, and Sinha, patient fulfils the candidacy

left ear and the CROS hearing aid were fitted together there was significant improvement in the puretone aided and speech discrimination response form the better as well as the poorer side. This arrangement is similar to the BICROS model with the difference that the microphone are not connected in the same circuit, termed here as Modified BICROS (MBICROS). With MBICROS the aided puretone average improved to 35dBHL and 43 dBHL when the stimuli were delivered from the better and poorer ear respectively. Similarly the Speech Discrimination Score improved to 70% when the stimuli were delivered from the poorer side and 90% for the stimuli delivered from the better ear with the MBICROS on. Localization ability improved significantly which is expected in the cases using the CROS hearing aids. It was interestingly reported by the case that his sense of imbalance as well as the balance in the gait also improved. Perhaps one can interpret this as the biannual stimulation is reaching the ear although in the same ear but some fusion may be possible at the higher centers. Clinician must continue to provide better option of amplification even the best amplification device has been provided to the cases. The amplification protocol must not end at one style of the hearing aid but it must continue considering the benefit of the amplification devices.

CONCLUSION: Generally audiologists' prescribe the hearing aid in the better ear (when the loss is asymmetrical) on the basis of pure tone thresholds and speech discrimination scores. The monaural fitting improves the performance of hearing abilities but the directionality aspect is left unattended. The present study shows although discrimination in the presence of the ambient noise and poor response to sound stimuli when incident from the poor ear side. Patient also reported having balance problem which he can even feel while walking. Providing CIC in the better ear brought the hearing levels near to normal, and the other ear remains unaidable (Speech Discrimination Scores 0%). Thus the candidacy for the CROS hearing aid was met. Case was fitted with CROS hearing aid along with CIC in the left ear. This arrangement termed as MBICROS was found to improve the localization and speech discriminations scores when sound incident from the poorer ear side of the case. Clinician must continue to provide better option of amplification even the best amplification device has been provided to the cases. The amplification protocol must not end at one style of the hearing aid but it must continue considering the benefit of the amplification devices.

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