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# Audiological Challenges in Management of Unilateral Hearing Loss/Asymmetrical Hearing Loss

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## ABSTRACT

**Introduction:** Hearing impairment is one of the most frequent sensory deficits in the human population affecting more than 250 million people around the world. Among them nearly 13.3% are affected with asymmetrical or unilateral hearing loss.
**Objective:** To explain the audiological challenges in management of unilateral profound hearing loss in one ear and mild to moderate hearing loss in the opposite ear.
**Design:** case study
**Methodology:** The study includes a single case report of a unilateral hearing loss client age 25 has undergone cochlear implantation followed by sudden hearing loss in the better ear. Pre and postoperative audiological evaluations were carried out using standard protocol
**Conclusion:** This study discloses the importance of early cochlear implantation over other management options and the consideration of the traditional 60db rule for the purpose of hearing aid fitting.

***Keywords:*** Hearing impairment, asymmetrical hearing loss, cochlear implantation

## INTRODUCTION

Unilateral hearing loss (UHL) or Single sided deafness (SSD) occurs when the hearing in one ear is within normal limits and the other ear has a hearing loss ranging from mild to profound (Elizabeth Hough, Neil Donnelly & David Baguley, 2oo9). A difference in hearing sensitivity of 30 dB or Speech Discrimination Score (SDS) of 20% between the better ear and poorer ear can be considered as asymmetrical hearing loss (Dilon, 2012).

Estimates from newborn hearing screening programs suggest approximately one congenital UHL per 1000 births, with UHL, thought to comprise about one-third of all children born with hearing loss. The prevalence of UHL increases with age as delayed-onset congenital hearing loss (HL) and acquired etiologies emerge, such that the prevalence increases to 14% among adolescent's ages 12–19 years. In the United States several studies have indicated the prevalence of UHL in children ranges from 0.03% - 3.00% depending on the age of the child. (Poter & bess 2011). A study published in 1998 estimated that the prevalence of UHL in school-age children ranged from 6.4 to 12.3 per 1000 (Lee, Gomez- Marin, and Lee, 1998).

The chief complaint for the majority of patients with unilateral hearing loss is marked intolerance for the amplified sound. There are essentially many possible factors causing UHL. We have highlighted the few common etiologies which are the major contributors for unilateral hearing loss in the Table1.

Despite these conditions the recent advancement in the hearing technology has

enabled the person to connect better with the environment. Appropriate intervention according to the etiology is essential. In case if the etiology is restricted within the inner ear the cochlear implant was recommended. If the etiology is located in an auditory nerve or central auditory system the outcome is unpredictable. Hence, the clarification about the etiology is crucial for planning the intervention.

Persons with and persons those who are likely to develops UHL becomes more aware of the importance of binaural hearing in their daily life in terms of social interaction and communication. The traditional concept of normal speech and language development through one normal-hearing ear has been suppressed in the recent past. Certain studies have shown that even a mild degree of unilateral hearing loss (UHL) can have adverse effects on language development (Lieu 2004)

**Table 1 – Etiology of Unilateral hearing loss**

| Causes of unilateral hearing loss | Prevalence among all children with unilateral hearing loss (%) | Reference |
|---|---|---|
| Unknown/no risk factors | 31-54 | Declau et al.2008;Ghogomu et al.2014 |
| Congenital causes General congenital causes | 45 | Ghogomu et al.2014; |
| Cochlear nerve deficiency | 26-50 | Clemmens et al.2013;Nakano et al.2013 |
| Developmental delay | 21 | Haffey et al.2013 |
| Premature birth | 20 | Haffey et al.2013 |
| Low birth weight | 6-20 | Declau et al.2008; Haffey et al.2013 |
| Hereditary | 3-11 | Declau et al.2008; Ghogomu et al.2014 |
| Hyperbilirubinemia | 5-11 | Declau et al.2008;Friedman et al 2013; Haffey et al.2013 |
| In utero infections | 3-7 | Declau et al.2008;Friedman et al 2013; Ghogomu et al.2014 |
| Craniofacial anomalies | 5 | Declau et al.2008; |
| Deafness syndrome | 4 | Declau et al.2008; |
| Low APGAR score | 2 | Declau et al.2008; |
| Acquired causes Ototoxic medication/ intravenous antibiotic use | 3-21 | Declau et al.2008;Friedman et al 2013; Haffey et al.2013 |
| Prolonged stay in neonatal intensive care unit | 14-20 | Friedman et al 2013; Haffey et al.2013 |
| Mechanical ventilation | 4-17 | Declau et al.2008;Friedman et al 2013; Haffey et al.2013 |
| Meningitis | 3-5 | Ghogomu et al.2014; Haffey et al.2013 |
| Head trauma | 3-4 | Ghogomu et al.2014; Haffey et al.2013 |

From the physiological point of view, the binaural hearing has been proven to be superior over unilateral hearing as it renders an adequate hearing experience using the three principles: 1) The squelch effect [ability of the brain to separate sound and noise signals from spatially separated sources] 2) The binaural summation effect [redundancy of auditory input] 3) The head shadow effect [better signal-to-noise ratio]. Due to the effect of overloading and bombarding in better ear, hair cells become more vulnerable and are prone to hearing loss.

## MATERIALS AND METHODS

A single case representation of a client age 25 years came to the department, with a history of congenital profound hearing loss in left ear and history of mild hearing loss in right ear for which he was using hearing aid in right ear for past 10 years. The client was earlier prescribed for cochlear implantation but was not willing to opt the same. There was sudden deterioration of hearing in the right ear (profound hearing loss) one month back for which there was no improvement with conservative treatment and the client has other medical history of right Eye surgery (lens and retinal surgery) for trauma to the right eye at the age of 18 years history of tongue tie release at the age of one year. His previous audiological report reveals congenital profound hearing loss in the left ear and mild to moderate sensory neural hearing loss in the right ear. No information on the presence or absence of a cochlear

micro phonic was described in the clinical report.

Pure tone audiometry was carried out using Cello Inventies. Air conduction thresholds where measured using TDH-39 Supraaural headphones and the threshold results was obtained from the frequency 250 Hz – 8KHz. Puretone stimulus was used. Bone conduction thresholds were measured using (radio ear B-71). The threshold results were obtained from the frequency 250 Hz – 4 KHz. Modified Hughson and Westlake procedure was carried out. Degree of hearing loss calculated using the modified Goodsmann classification. The audiometer and transducer was calibrated using biological test and the correction factor was added on the threshold results.

Speech audiometry was carried out in Cello Inventies. Only Speech Awareness Level (SAL) was detected due to higher hearing loss threshold. Speech Awareness Level (SAL) was detected from the presentation level of (PTA+5dB).

Immittance Audiometry was done using Clarinet Inventies. The probe tone frequency used for the recording the measurement were 226Hz. Acoustic Reflexes Threshold were also done for both Ipsilateral and Contralateral ears and was measured using stimulus ear rule.

Distortion product Oto Acoustic Emission was carried out using Natus Echo port screener. Detailed diagnostic (OAE) was not carried out due to instrumental error.

Auditory Brainstem Response (ABR) was measured using IHS system. Stimulus parameter used for recording are: Transducer - ER3A insert earphones, Repetition rate-11.1/sec, Duration of the stimuli 100ms, Intensity-88dBnHL, Horizontal montage was carried out by placing negative electrode on the Test Ear Ground electrode on the Non Test Ear and positive electrode on the fore head position, Polarity used was Rarefaction, condensation and alternate polarity. Recording parameter used was Time window-10ms, Sweeps average 2000 per ms, Amplification 1,00,000 times, High pass filter -3000Hz, Low pass filter-150Hz.

Cochlear implant procedure was carried after a month of the detailed diagnostic evaluation. Right ear was operated and implanted Sonata Ti 100 Flex28 implant. The electrode insertion was done via round window. Complete insertion achieved intra-op impedance and Auditory Response Telemetry (ART) were satisfactory. Switch on was done after a month of surgery.

## RESULTS

### PTA (PURE TONE AUDIOMETRY)

The results were tabulated as mentioned in the methodology.

**Table 2 – Puretone Audiometry results**

| FREQUENCY (Hz) | 250 | 500 | 1000 | 2000 | 4000 | 8000 | PTA AVERAGE |
|---|---|---|---|---|---|---|---|
| RE(AC) | 100NR | 110NR | 120NR | 120NR | 120NR | 90NR | <116.6dB |
| LE(AC) | 100NR | 110NR | 120NR | 120NR | 120NR | 90NR | <116.6dB |
| RE(BC) | 45NR | 65NR | 75NR | 80NR | 75NR | - | |
| LE(BC) | 45NR | 65NR | 75NR | 80NR | 75NR | - | |

As far the threshold tabulated in Table 2 Both the ears given as the diagnosis of profound hearing loss as per the Modified Goodsmann classification.

### SPEECH AUDIOMETRY

The results were tabulated as mentioned in the methodology.

**Table 3 – Speech audiometry results**

| EAR | SAL |
|---|---|
| RE | <100dB |
| LE | <100dB |

### IMMITTANCE AUDIOMETRY:

The results were tabulated as mentioned in the methodology.

**Table 4 – Immitance Audiometry results**

| EAR | EAR CANAL VOLUME (cc) | PEAK PRESSURE (daPa) | STATIC COMPLIANCE (ml) |
|---|---|---|---|
| RE | 1.66 | -3 | 1.02 |
| LE | 1.34 | 0 | 0.98 |

According to the result tabulated in Table 4 Both Ears has shown “A” Type

Tympanogram with absent reflexes. The impression was given as no middle ear pathology.

**OAE (OTO ACOUSTIC EMISSION):**

The Echo Port Screener had shown in the results of OAE as REFER in all core frequency(500Hz.1000Hz.2000Hz.4000Hz).

**ABR (AUDITORY BRAINSTEM RESPONSE):**

The results were tabulated as mentioned in the methodology.

**Table-5 – Auditory Brainstem response**

| EAR | I PEAK | III PEAK | V PEAK |
|---|---|---|---|
| RE | NR | NR | NR |
| LE | NR | NR | NR |

Auditory Brainstem Responses did not shown any responses in Vth peak in rarefaction condensation polarity at 11.1/sec repetition rate at 88 dBnHL using click stimuli.

## DISCUSSION

In the past, treatment modalities to restore binaural hearing solely relied on amplification devices that transmit sound, through air or bone, from the deafened ear to the contralateral, normal ear. Such technologies include air conduction contralateral routing of sound (CROS), transcranial CROS (t-CROS), and bone conduction technologies including the Bone-Anchored Hearing Appliance. An air conduction CROS hearing aid (HA) is decades-old technology that consists of a microphone placed in the deafened ear which transmits sound via a wire or wirelessly to a receiver that is placed in the normal hearing aid, thereby averting the negative head shadow effect in monaural listeners. Due to inexpensiveness, and ease of use and fitting, CROS hearing aids typically are the first line intervention for SSD. Though users have endorsed subjective benefits from restoring the head shadow effect by allowing sound awareness from the deaf side, this success has been tempered by its drawbacks, including the need to occlude the better ear canal and relatively poor overall improvement in hearing experience, particularly concerning to hearing in noise and sound localization

Despite the improvement in hearing in noise and localization reported by (Bone Anchored Hearing Aid) BAHA and CROS users, they do not provide bilateral auditory input, which is needed for actual binaural hearing hence cochlear implantation has been used traditionally for treating bilateral profound hearing loss which is recently been proposed as one of the appropriate management options for UHL specifically because it ensures the stimulation of the poorer ear. Speech perceptions concerning a unilateral implant for SSD are an increased speech understanding, especially in noisy environments, and a decreased effort to hear.

• Treatment options based on 60dB rule:

Fit the ear that has the four-frequency average (4FA) threshold closer to 60 dB HL.

- If the pure tone thresholds are greater than 60dB- better ear has to be fitted
- If the pure tone thresholds are lower than 60dB-Poorer ear has to be fitted.

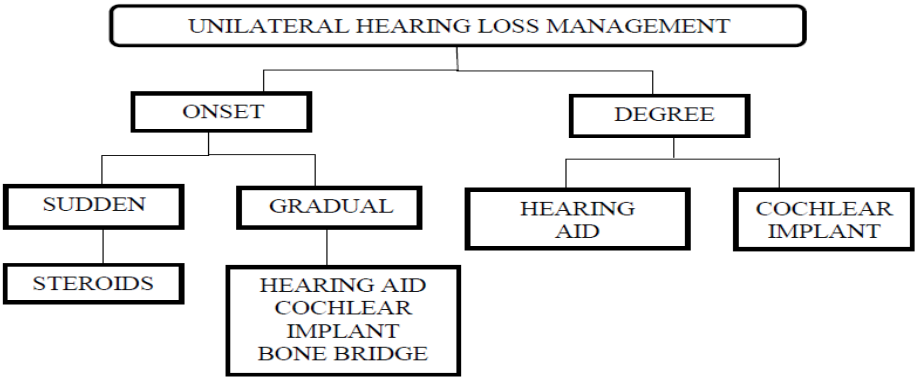


**Figure 1: Flowchart representation of unilateral hearing loss management**

A prolonged period of unilateral hearing or pseudo hearing can lead to hearing deterioration in the better ear. To avoid the same, cochlear implantation has to be considered over other management options in asymmetrical or unilateral hearing loss cases. In UHL binaural stimulation has to be focused, in case of monaural fitting poorer ear should not be left untreated. Appropriate treatment options have to be considered as early as possible for the betterment of the patients. Inadequacies in the recent advancements in most of the clinical settings make the patient suffer more. Traditional 60dB rule should be reconsidered and formulated to better management options for greater benefits.

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