Impact of Unilateral Hearing Loss

It has been acknowledged and established for decades that despite normal hearing in one ear, children with significant unilateral hearing loss (UHL) face educational, social, cognitive, and behavioral challenges (Bess, 1986; Bess et al., 1986; Borton et al., 2010; Lieu, 2004; Lieu et al., 2013; Niedzielski et al., 2006; Ruscetta et al., 2005; Tharpe, 2008). When it comes to communication, these children face difficulties with language (Lieu et al., 2010; 2013; Sangen, 2017), understanding speech in noise (Griffin, Poissant, & Freyman, 2018), localization (Reeder, Cadieux, & Firszt, 2015), and report poorer quality of life than their peers with normal hearing in both ears (Griffin, Poissant, & Freyman, 2018).

Children with UHL appear to require greater auditory effort to understand speech. In a classroom setting, this can result in greater fatigue in multiple domains – including cognitive fatigue that leads to negative impacts on learning (Hornsby et al., 2013). As audition is integrated into brain functions such as sequencing, sensory-motor control, and executive function, the lack of hearing from an early age may have cascading negative effects on higher level brain functions (Conway, Pisoni, & Kronenberger, 2009; Sharma, Dorman, & Spahr, 2002). Multiple studies support this theory (Ead et al., 2013; Polonenko, Papsin, & Gordon, 2018; Propst et al., 2010; Tibbets et al., 2011) In fact, Propst et al. (2010) reported that children with UHL have less activation of higher level auditory attention centers in the brain than children with normal hearing in both ears and suggest that this may be the cause of the increased rates of behavior and attention difficulties.

Treatment of Unilateral Hearing Loss
Despite the known impact of UHL in children, our ability to treat and provide habilitation has been limited. When children have severe UHL, conventional hearing aid amplification is typically not beneficial. Traditionally, treatment has involved re-routing the signal to the better hearing ear through the use of Contralateral Routing of the Signal (CROS) hearing aids and bone-conduction devices. A CROS hearing aid uses a microphone/transmitter on the poorer hearing ear to send the acoustic signal to the receiver on the better hearing ear. Bone-conduction devices use vibratory stimulation to transmit the signal to the cochlea on the side with better hearing. For both of these devices, only one auditory pathway is stimulated, and though listeners receive a signal from each side, they are unable to use binaural cues when they are being perceived in only one ear. This inability to stimulate both auditory pathways results in variable speech understanding in noise (Kunst et al, 2007; Updike, 1994) and poor localization (Bosman et al, 2003; Hol et al, 2010).

A cochlear implant would provide stimulation to both auditory pathways in cases of UHL. In doing so, cochlear implants benefit this population by improving speech understanding in the poorer hearing ear and offering binaural cues for improved localization and speech understanding in noise. Stimulating both auditory pathways may improve auditory function and in turn, improve quality of life, fatigue, and behavior. By treating severe UHL early, it may be possible to prevent the educational, social, cognitive, and behavioral challenges these children otherwise experience.

In many other countries, cochlear implantation has become an accepted treatment for patients with UHL. Literature regarding adult subjects with UHL who receive cochlear implants report that it is a beneficial treatment. Benefits have been noted in localization, speech understanding in quiet and in noise, and quality of life (Dillon et al., 2017a; 2017b; Firszt et al., 2012; Galvin et al., 2018; Sladen et al., 2017). Further, cochlear implantation has been shown to offer superior speech understanding in noise, localization, and subjective perception of hearing quality compared to currently approved devices for UHL, such as CROS hearing aids and bone-conduction devices (Arndt et al., 2011).

**Cochlear Implantation in Children with Unilateral Significant Hearing Loss**

The practice of providing cochlear implants to children who have significant hearing loss in one ear is of great interest and is occurring with greater frequency as reported in case studies and small set clinical reports. These papers have indicated that cochlear implants can improve speech understanding in noise (Arndt et al., 2015; Hassepass et al., 2013; Távora-Vieirea & Rajan, 2015; Zeitler et al., 2019), localization (Arndt et al., 2015; Hassepass et al., 2013; Plontke et al., 2013; Távora-Vieirea & Rajan, 2015), and single word recognition in quiet (Greaver, Eskridge, & Teagle, 2017; Plontke et al., 2013). There are even reports of restoration of bilateral cortical auditory function (Polonenko et al., 2017) and cortical reorganization (Sharma et al., 2016) in children with UHL following cochlear implantation.

An important consideration for children is the possibility of hearing loss progression in
the contralateral ear. Studies have indicated progression in anywhere from 11% (Uwiera et al., 2009) to 40% (Fitzpatrick et al., 2017) of children with UHL. Unfortunately, we are not able to predict which children will ultimately face bilateral hearing loss. Placing a cochlear implant in the poorer hearing ear soon after identification takes advantage of early intervention and neural plasticity, providing the best opportunity for binaural hearing throughout a child’s life.

Significant UHL is not an approved FDA indication for cochlear implantation, however, the literature supports cochlear implantation as a beneficial treatment option over currently approved treatment options for UHL. Recent findings from our colleagues Griffin, Poissant, and Freyman (2018) draw attention to the difficulties faced by children with UHL, and they poignantly state that their findings “add to the growing literature challenging the past assumption that one ear is ‘good enough.’” Waiting for the completion of more clinical trials and ultimate FDA approval of the indication in children could result in irreversible impact to a child’s educational and social function. For these reasons, many insurance companies and even Medicaid in some states are providing coverage for cochlear implantation. We would urge other carriers to follow suit, helping children take advantage of the critical period of neural plasticity and promote binaural hearing as early as possible

References


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