

Exclusive sample work

**CLINICAL EFFICACY OF COCHLEAR IMPLANT SURGERY
IN PEDIATRIC AND ADULT PATIENTS:
A COMPREHENSIVE REVIEW**

Abstract

Background and Objective: Hearing loss, often known as hearing impairment, is a condition in which hearing is affected partially or completely. Hearing loss affects one out of every eight persons globally. The current systematic review's primary goal was to examine the clinical efficacy of CI surgery in paediatric and adult patients.

Methods: The current study was carried out as a systematic review in accordance with the PRISMA standards. We searched the PubMed, MEDLINE, EMBASE, and Google Scholar databases for relevant literature on the clinical efficacy of CI surgery using the proper key phrases (MeSH).

Results: This review contained 73 studies that fulfilled the inclusion criteria. The research involving unilateral CI in adults revealed considerable improvements in perceptual ability. Compared to unilateral CI, Bilateral CI studies give advantages in quiet hearing and sound localization. Age is not a decisive element in patients' performance of post-CI outcomes.

Conclusion: For the vast majority of patients with mild to severe hearing loss, CI is helpful assistance in communication and speech perception. More research with big databases, patient registries for long-term follow-up details, higher-quality reporting, and longer length are required to create stronger evidence.

INTRODUCTION

More than 550 million people worldwide suffer from hearing loss. Around 60 million people have acute hearing loss or worse (Smulders et al., 2016; Stevens et al., 2013). Cochlear implants are one of the most significant advances in contemporary medicine (CI) (Farinetti et al., 2014). Many infants with a CI before age 12 experience typical language development due to the procedure (Birman et al., 2016). Previously, CI was primarily deployed to deaf children. Recently, paediatric and adult patients with progressive hearing loss following a middle ear procedure, severe sensorineural hearing loss, and progressive hearing loss have been identified as potential candidates for CI (Louza et al., 2018). Although CI surgery is generally low-risk, internal implantation surgery with the CI device is not entirely risk-free and may result in problems requiring revision surgery (Amaral et al., 2019).

According to studies, around 45% of participants experienced dizziness after implantation (Services, 2014). These problems are due to device failure, foreign body implantation, or surgical technique (McRackan et al., 2012). Minor issues are managed conservatively with medical procedures such as non-auditory stimulations and wound infection. The principal consequences of CI surgery are middle air infection necessitating revision surgery due to flap necrosis, irreversible facial paralysis, electrode failure, meningitis, and implant site skin infection (Ikeya et al., 2013). Several research studies on the clinical efficacy of CI surgery in paediatric and adult patients have been widely published (Scarabello et al., 2020; Gao et al., 2020; ka Cesur & Derinsu, 2020). However, a comprehensive review of this research has been revealed to be quite limited in number (Berrettini et al., 2011; Forli et al., 2011), and these investigations were conducted roughly 10 years ago.

Furthermore, no systematic studies have been conducted regarding the clinical efficacy of CI surgery in juvenile and adult patients. An updated systematic evaluation of the clinical effectiveness of CI surgery is required to bridge this knowledge gap and boost research on CI surgery. Thus, the primary goal of this study was to determine the clinical efficacy of unilateral CI with bimodal stimulation vs unilateral CI vs bilateral CI operations in paediatric and adult patients.

MATERIALS AND METHODS

Study Design

For this systematic review, the PRISMA guidelines were followed (Moher et al., 2015).

Search Strategy

A literature search was conducted using the necessary key phrases in the following databases: PubMed MEDLINE, Scopus, and Cochrane (MeSH). We were primarily seeking studies on the clinical efficacy of CI surgery. Different keyword combinations and medical subject headings (MeSH) were used to generate two subsets of citations: one for "Cochlear Implant," using MeSH and terms like "unilateral", "bilateral", "bimodal stimulation", and the other for its management, using words and MeSH like surgery, resection, bypass, and so on. To search other databases, the keywords were changed according to the searching protocol of each database, including paediatric cochlear implant surgery, adult cochlear implant surgery, cochlear implant surgery in children, unilateral cochlear implant surgery, bilateral cochlear implant surgery, and bimodal cochlear implant surgery.

Inclusion and exclusion criteria

This study covered all original research publications published in English between 2000 and 2020 on the clinical efficacy of CI surgery. Exclusion criteria were (a) provided abstracts, letters to the editors, comments, systematic review or meta-analysis papers, and (b) the absence of the complete text of the study. Non-English studies and those published before the year 2000 were also excluded.

Strategy to assess the quality of studies

The article screening and eligibility evaluation were carried out separately by two authors. In the event of a disagreement amongst the authors, the decision was decided by an unbiased third party. The publications were examined initially based on their titles and abstracts. If the title and abstract of an article were extraneous to the current study, it was removed from the secondary screening.

Data extraction

During an initial literature search, a total of 2086 papers on the clinical efficacy of CI surgery were discovered. After applying the eligibility criteria, relevant articles were chosen for full-text screening. The full-text evaluated publications were also excluded due to inadequate information about the clinical efficacy of CI surgery. The author's name and year, sample size, research design and age, devices, findings, and outcomes were retrieved from the selected publications.

Outcome measure

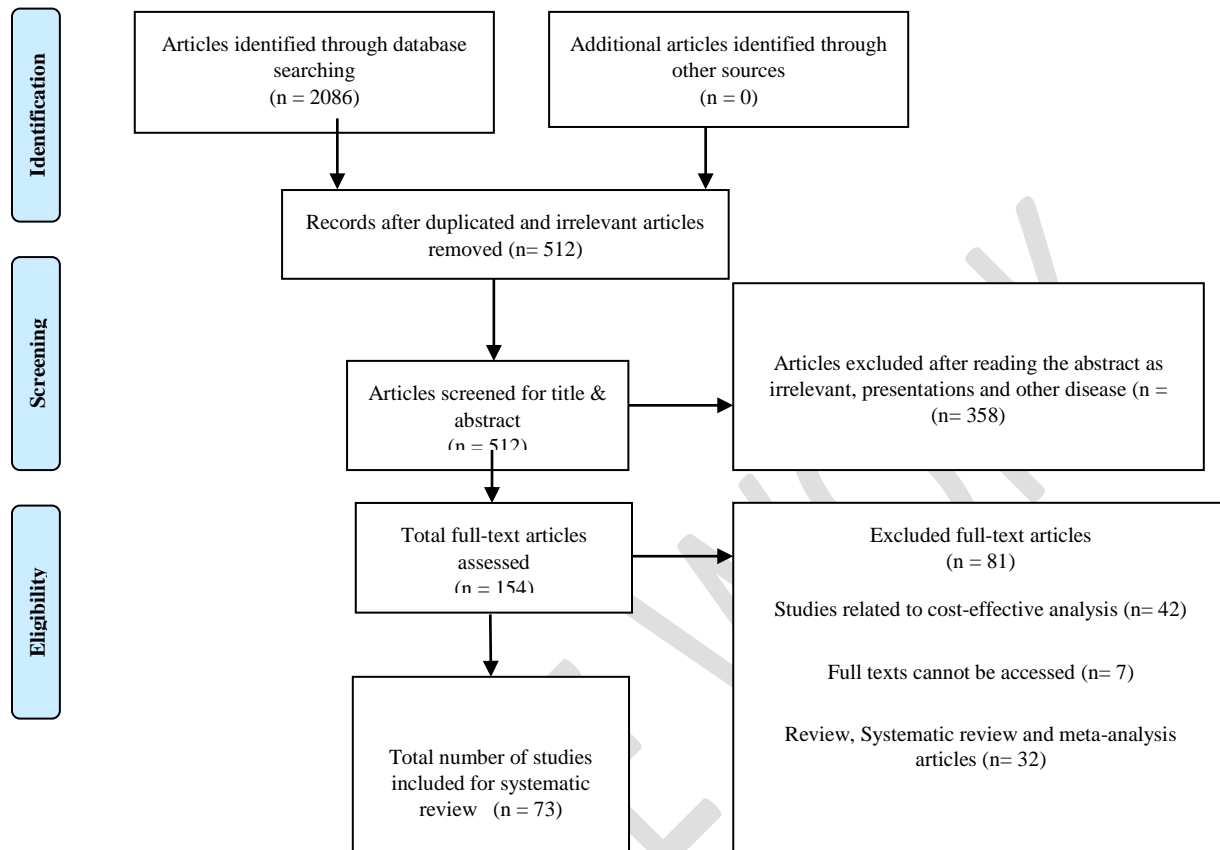
The clinical efficacy of cochlear implant surgery (i.e., language and communication outcomes and audio logical results) is the primary end measure of the current review, followed by the kind of cochlear implant surgery (i.e., unilateral, bilateral) and patient categorizations (i.e., adults, paediatrics).

RESULTS

Eligible studies

A total of 2086 papers were found through a literature search in various databases such as Google Scholar, Ovid, PubMed, and Science Direct, of which 1574 were discarded at the outset owing to duplication and irrelevance. After analyzing the titles and abstracts at the first screening stage, 358 articles were eliminated from the total of 512. A total of 154 possibly relevant publications were chosen for full-text evaluations, of which 81 were further discarded as research linked to cost-effective analysis (n= 42), full texts could not be found (n=7), and review, systematic review, and meta-analysis articles (n= 32). Finally, as shown in fig.1. 73 studies on CI surgery in paediatric and adult patients were considered in our current systematic review analysis.

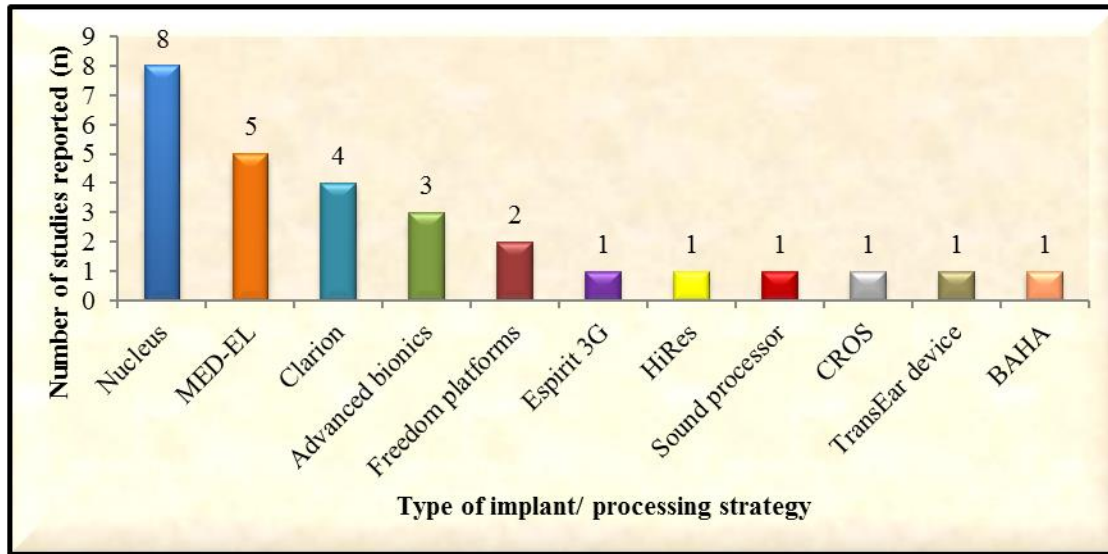
FIGURE 1: PRISMA flow chart



Unilateral CI surgery in adult patients

The findings of the included studies revealed that age is not a decisive factor in the performance of post-CI outcomes in patients. The quality of life of adult patients improved statistically significantly. In contrast, Park et al. (2011) found that while the quality of life increased in all age groups, it was not statistically significant. According to Roberts et al. (2013), a family history of hearing loss is associated with a tendency toward greater speech recognition. According to Dillon et al. (2017), CI might provide considerable increases in quality of life in severe unilateral hearing loss (UHL). Various research employed a different cut-off age. Age disparities have an effect on results. Dixon et al. (2019) recently demonstrated clinically substantial improvement in Tinnitus Handicap Inventory patients (THI). Figure 2 depicts the most often utilized processing techniques and implant types.

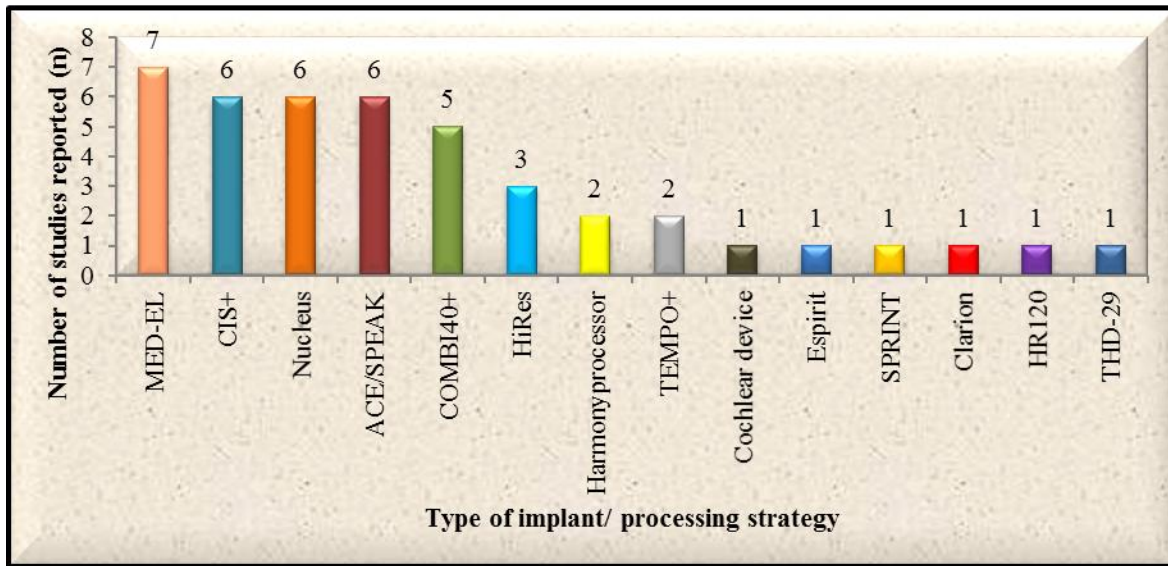
FIGURE 2: Type of implant/processing strategies used for adult patients with unilateral CI



Unilateral CI vs Bimodal stimulation vs Bilateral CI in adult patients

Wackym et al. (2007) examined the perceived benefits of unilateral versus bilateral CI reported in the APHAB questionnaire. Huinck et al. (2019) found that both met conservative requirements and that outside of this traditional criterion, patient groups saw a favourable impact of CI on quality of life. Compared to unilateral CI, Bilateral CI studies give advantages in quiet hearing and sound localization. However, there is significant inter-individual heterogeneity in the benefits acquired from the second implant. Figure 3 depicts the most often utilized processing techniques and implant types.

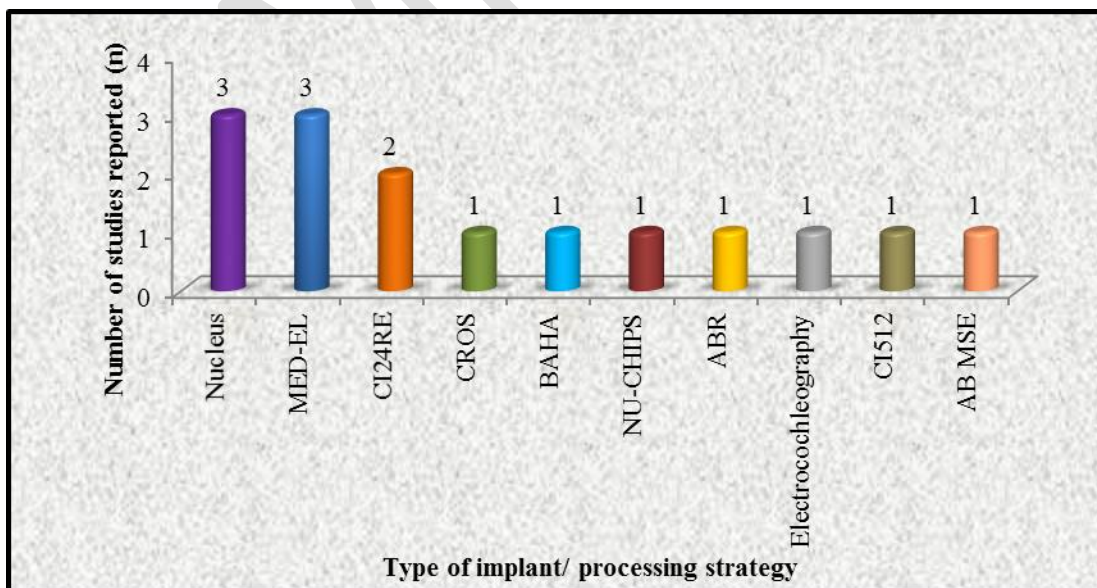
FIGURE 3: Type of implant/processing strategies used for adult patients with unilateral CI vs Bimodal stimulation vs Bilateral CI in paediatric patients



Unilateral CI surgery in paediatric patients

Scarabello et al. (2020) found that a longer time of CI usage, surgery at a younger age, and greater output of auditory speech processing influenced verbal and receptive oral language performance. Figure 4 depicts the most often utilized processing techniques and implant types.

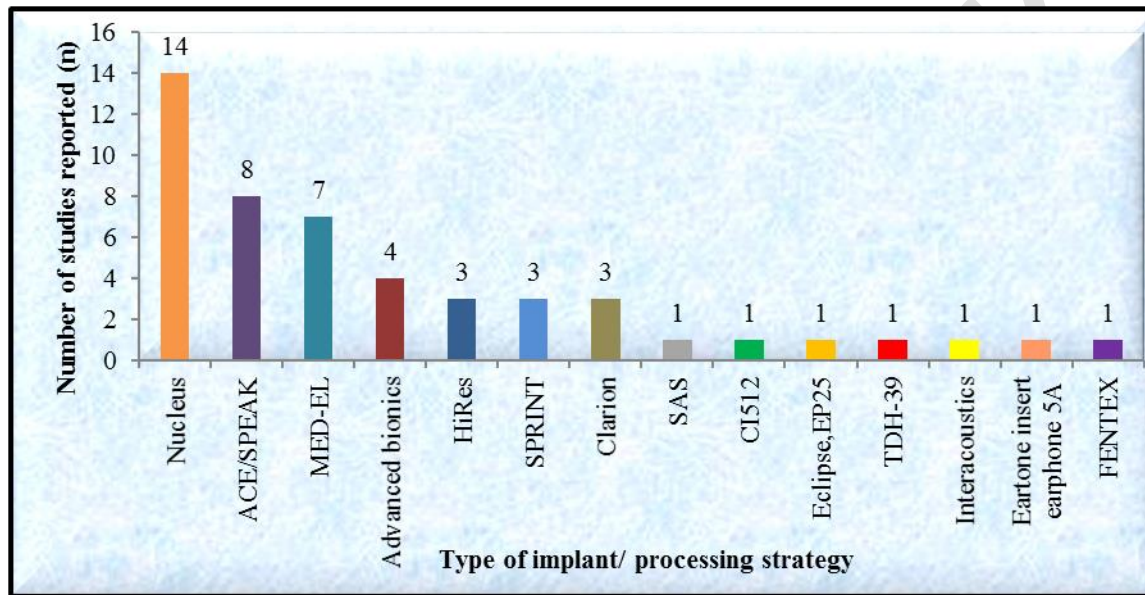
FIGURE 4: Type of implant/processing strategies used for pediatric patients with unilateral CI



Unilateral CI vs Bimodal stimulation vs Bilateral CI in paediatric patients

The summary of the included studies in this present review indicated that bilateral CI improves unilateral CI regarding hearing in a silent environment, sound localization, and hearing in noise. Figure 5 depicts the most often utilized processing techniques and implant types.

FIGURE 5: Type of implant/processing strategies used for pediatric patients with unilateral CI vs Bimodal stimulation vs Bilateral CI



DISCUSSION

Cochlear implants (CIs) are an excellent tool for people with hearing loss⁴⁴. The primary goal of this study is to evaluate the clinical efficacy of CI surgery in pediatric and adult patients. The included studies on unilateral CI in adults demonstrated a considerable increase in perceptual ability after CI surgery. Our findings are consistent with those of a prior systematic analysis by Gaylor et al. (2013), who found that unilateral CI considerably enhanced hearing ability in adult patients. In this investigation, aged individuals had worse perceptual findings than younger ones. Similarly, Roberts et al. (2013) discovered that older patients' assessment of speaking competence was much lower than that of younger adult patients.

The findings of the included studies revealed that age is not a decisive factor in the performance of post-CI outcomes in patients. Similarly, various studies have demonstrated that

CI benefits elderly persons, especially regarding their quality of life and listening abilities. As a result, age is neither a predictor nor a limiting factor in patients' post-CI results. Similarly, Lachowska et al.²³ established that age is not a limiting factor for the post-CI outcome in senior patients. When compared to unilateral CI, our current comprehensive review found that bilateral CI in adult patients improves hearing in a silent environment, sound localization, and hearing in noise.

Similarly, Gaylor et al. (2013) discovered substantial gains in sound localization after bilateral CI in adult patients in a comprehensive study. Compared to unilateral CI, bilateral CI improves young patients' hearing in a silent environment, sound localization, and listening to noise. According to the study findings, which correspond with the earlier systematic analysis by Forli et al. (2011), bilateral CI gives several advantages in pediatric patients, including hearing in loud and calm environments and sound localization over unilateral CI. Furthermore, Strom-Roum et al. (2012) found that bilateral CI resulted in statistically significant improvement in patients over unilateral CI.

There are certain limitations to the current systematic review. The eligible publications in this systematic evaluation of the clinical effectiveness of CI surgery employed a variety of processing algorithms and implant types. This difference highlighted a lack of standardized, uniform, and appropriate therapy for people with hearing loss difficulties. This review did not analyze the possibility of bias since most research used different study designs. Despite these limitations, this revised systematic review provides a data-driven assessment of the clinical effectiveness of CI surgery in pediatric and adult patients.

CONCLUSION

Hearing loss is a common issue caused by hereditary factors, disease, ageing, birth problems, and noise. CI has long been a routine technique for persons with moderate to severe hearing loss. Without an implant, people may still rely on others for ordinary day-to-day activities. As a result, CI implants are a viable therapy option for people who have complained of hearing loss.

References

- Amaral, M.S.A. do, Reis, A.C.M.B., Massuda, E.T. & Hyppolito, M.A. 2019. Cochlear implant revision surgeries in children. *Brazilian Journal of Otorhinolaryngology*. (85)3,. pp. 290–296.
- Berrettini, S., Baggiani, A., Bruschini, L., Cassandro, E., Cuda, D., Filippo, R., Palla, I., Quaranta, N. & Forli, F. 2011. Systematic review of the literature on the clinical effectiveness of the cochlear implant procedure in adult patients. *Acta Otorhinolaryngologica Italica*. (31)5,. pp. 299.
- Birman, C.S., Powell, H.R.F., Gibson, W.P.R. & Elliott, E.J. 2016. Cochlear Implant Outcomes in Cochlea Nerve Aplasia and Hypoplasia. *Otology & Neurotology*. (37)5,. pp. 438–445.
- Dillon, M.T., Buss, E., Rooth, M.A., King, E.R., Deres, E.J., Buchman, C.A., Pillsbury, H.C. & Brown, K.D. 2017. Effect of Cochlear Implantation on Quality of Life in Adults with Unilateral Hearing Loss. *Audiology and Neurotology*. (22)4–5,. pp. 259–271.
- Dixon, P.R., Crowson, M., Shipp, D., Smilsky, K., Lin, V.Y., Le, T. & Chen, J.M. 2019. Predicting Reduced Tinnitus Burden After Cochlear Implantation in Adults. *Otology & Neurotology*. pp. 1.
- Farinetti, A., Ben Gharbia, D., Mancini, J., Roman, S., Nicollas, R. & Triglia, J.-M. 2014. Cochlear implant complications in 403 patients: Comparative study of adults and children and review of the literature. *European Annals of Otorhinolaryngology, Head and Neck Diseases*. (131)3,. pp. 177–182.
- Forli, F., Arslan, E., Bellelli, S., Burdo, S., Mancini, P., Martini, A., Miccoli, M., Quaranta, N. & Berrettini, S. 2011. Systematic review of the literature on the clinical effectiveness of the cochlear implant procedure in paediatric patients. *ACTA otorhinolaryngologica italica*. (31)5,. pp. 281.
- Gao, Z., Wang, S., Yang, H., Feng, G., Shang, Y., Wang, B., Tian, X., Li, Y., Wei, X. & Shu, Z. 2020. Simultaneous bilateral cochlear implantation in children aged 12–18 months is safe and can be performed using standard cochlear implant surgical techniques. *European*

Archives of Oto-Rhino-Laryngology.

- Gaylor, J.M., Raman, G., Chung, M., Lee, J., Rao, M., Lau, J. & Poe, D.S. 2013. Cochlear implantation in adults: a systematic review and meta-analysis. *JAMA Otolaryngology Head & Neck Surgery.* (139)3,. pp. 265–272.
- Huinck, W.J., Mylanus, E.A.M. & Snik, A.F.M. 2019. Expanding unilateral cochlear implantation criteria for adults with bilateral acquired severe sensorineural hearing loss. *European Archives of Oto-Rhino-Laryngology.* (276)5,. pp. 1313–1320.
- Ikeya, J., Kawano, A., Nishiyama, N., Kawaguchi, S., Hagiwara, A. & Suzuki, M. 2013. Long-term complications after cochlear implantation. *Auris Nasus Larynx.* (40)6,. pp. 525–529.
- ka Cesur, S. d & Derinsu, U. 2020. Temporal processing and speech perception performance in postlingual adult users of cochlear implants. *Journal of the American Academy of Audiology.* (31)02,. pp. 129–136.
- Louza, J., Klappert, C.L., Ledderose, G., Gürkov, R. & Krause, E. 2018. Cochlear Implant Surgery and the Risk of Falls in an Adult Population. *Otology & Neurotology.* (39)2,. pp. e74–e79.
- McRackan, T.R., Reda, F.A., Rivas, A., Noble, J.H., Dietrich, M.S., Dawant, B.M. & Labadie, R.F. 2012. Comparison of Cochlear Implant Relevant Anatomy in Children Versus Adults. *Otology & Neurotology.* (33)3,. pp. 328–334.
- Moher, D., Shamseer, L., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., Shekelle, P. & Stewart, L.A. 2015. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic reviews.* (4)1,. pp. 1.
- Park, E., Shipp, D.B., Chen, J.M., Nedzelski, J.M. & Lin, V.Y.W. 2011. Postlingually Deaf Adults of All Ages Derive Equal Benefits from Unilateral Multichannel Cochlear Implant. *Journal of the American Academy of Audiology.* (22)10,. pp. 637–643.
- Roberts, D.S., Lin, H.W., Herrmann, B.S. & Lee, D.J. 2013. Differential cochlear implant outcomes in older adults. *The Laryngoscope.* (123)8,. pp. 1952–1956.

- Scarabello, E.M., Lamônica, D.A.C., Morettin-Zupelari, M., Tanamati, L.F., Campos, P.D., Alvarenga, K. de F. & Moret, A.L.M. 2020. Language evaluation in children with pre-lingual hearing loss and cochlear implant. *Brazilian Journal of Otorhinolaryngology*. (86)1., pp. 91–98.
- Services, U.S.D. of H. and H. 2014. *National Institute on Deafness and Other Communication Disorders. Cochlear implants*.
- Smulders, Y.E., van Zon, A., Stegeman, I., Rinia, A.B., Van Zanten, G.A., Stokroos, R.J., Hendrice, N., Free, R.H., Maat, B. & Frijns, J.H.M. 2016. Comparison of bilateral and unilateral cochlear implantation in adults: a randomized clinical trial. *JAMA otolaryngology head & neck surgery*. (142)3., pp. 249–256.
- Stevens, G., Flaxman, S., Brunskill, E., Mascarenhas, M., Mathers, C.D. & Finucane, M. 2013. Global and regional hearing impairment prevalence: an analysis of 42 studies in 29 countries. *The European Journal of Public Health*. (23)1., pp. 146–152.
- Strom-Roum, H., Laurent, C. & Wie, O.B. 2012. Comparison of bilateral and unilateral cochlear implants in children with sequential surgery. *International Journal of Pediatric Otorhinolaryngology*. (76)1., pp. 95–99.
- Wackym, P.A., Runge-Samuels, C.L., Firszt, J.B., Alkaf, F.M. & Burg, L.S. 2007. More Challenging Speech-Perception Tasks Demonstrate Binaural Benefit in Bilateral Cochlear Implant Users. *Ear and Hearing*. (28)Supplement., pp. 80S-85S.