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Review Article

Complications of cochlear implant surgery: a review

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ABSTRACT

A safe and proven surgical technique for auditory rehabilitation in cases of severe to profound hearing loss is cochlear implantation. The purpose of the CI is to convert auditory information into electric stimulation and to stimulate the cochlear nerve. Cochlear implantation is currently a common surgical technique due to the rise of CI candidates in recent years. The associated complication rates remain high even with the advancements in cochlear implantation procedures. One of the main concerns during CI surgery is infection. Implant extrusion, implant sepsis, migration of electrode, flap related problems, meningitis, and persistent non-auditory stimulation are major complications of cochlear implantations. Major complications are less common compared to the minor complications. The minor complications of cochlear implantations include tympanic membrane perforation, ear canal fenestrations, transient facial nerve paresis, chorda tympani nerve (CTN) injury, vertigo, and tinnitus. Device failure is the cause of second surgery and reimplantation. The clinicians/otologists should be aware of the possible complications of CI surgery. This article reviews different types of minor and major complications associated with CI surgery.

Keywords: Cochlear implantation, Complications of CI surgery, Facial nerve paralysis, Meningitis, Device failure

INTRODUCTION

Cochlear implantation has become an established surgical procedure for the management of sensorineural hearing loss.[1] Expanding criteria of cochlear implantation is resulting in a significant increase in number of patients using such devices.[2] Despite the fact that many patients have had successful cochlear implantations, surgical problems still happen. Intraoperative, early postoperative (≤3 months post-implantation), and late postoperative (>3 months post-implantation) complications are the three categories into which complications of CI surgery can be divided.[3] Hematoma or seroma, wound infection, meningitis, facial nerve injury, perforation of tympanic membrane, vertigo, device failure, device extrusion, migration of electrode, trauma to implant site, damage to receiver stimulator, acute otitis media, and mastoid or cholesteatoma in children are the potential complications associated with CI surgery.[3] The complications due to cochlear implantation can be classified into major or minor.[4] Meningitis is one of the potentially serious side effects of CI surgery, hence caution should always be exercised, especially if a cerebrospinal fluid (CSF) gusher develops after the cochlea is opened.[5] Device failure, facial nerve twitching upon stimulation, and persistent ear infections with or without cholesteatoma are examples of late postoperative problems following CI surgery. The objective of this review paper is to discuss about details of complications of CI surgery.

LITERATURE SEARCH

We conducted a search for research articles on the complications of CI surgery using various methods. This began with searching online databases such as Scopus, PubMed, Medline, and Google Scholar. A search strategy was created based on the PRISMA (Preferred reporting items for systematic reviews and meta-analysis) guidelines. The search approach found published article abstracts, and citations were used to manually find more

research publications. The suitability of observational studies, comparative studies, case series, case reports, and randomized controlled trials for inclusion in this review was evaluated. A total of 72 articles (24 case reports, 17 case series, and 31 original articles) were found across various databases, with 55 being included in this review (Figure 1). This article discusses the prevalence, risk factors for CI surgery, and details of complications of CI surgery.

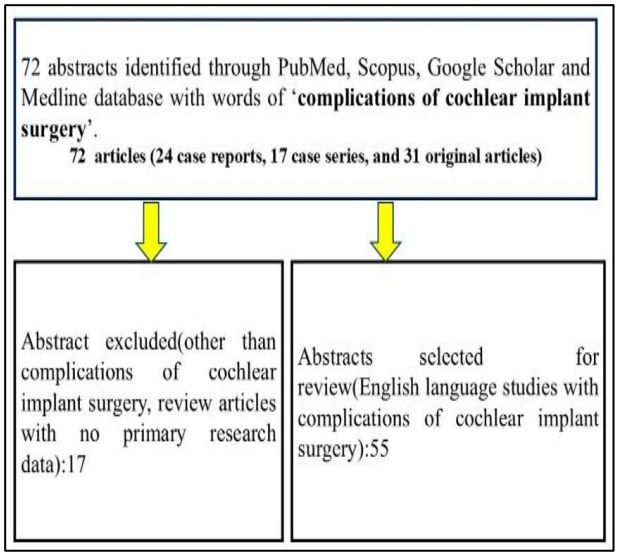

Figure 1: Methods of literature search.

PREVALENCE

CI is one of the most successful implants in medical practice. Worldwide, cochlear implantation surgery is conducted, and as technology advances, the procedure used is continuously being upgraded. With over one million patients already implanted, cochlear implantation is quickly becoming a standard procedure in many otological facilities.[6] Cochlear implantations have evolved though different techniques introduced to decrease the incidence of the postoperative complications associated with this surgical procedure. However, complications can occur following cochlear implantation regardless of the surgical technique used. The average incidence due to cochlear implantation ranges from to 18%.[7] Even while cochlear implantation complications still happen, they have been steadily declining over time; in earlier studies, they were 18.3% and 19.9%, respectively, and are currently only 5.6%.[8,9]

RISK FACTORS FOR COMPLICATIONS

Cochlear implantation is most frequently used to treat congenital deafness (81.6%) and progressive deafness of unclear cause.[10] Anatomical variations, surgical technique and surgeon's experience are very important factors that affect the complications due to cochlear implantation. Age is an important factor for manifesting complications of CI surgery.[10] Age less than 2.5 years are prone for major complications such as surgical wound infection. The vestibular symptoms are common in adults with cochlear implantation.[10] The vestibular symptom such as vertigo is less common among children between the age of 2.5 to 4 years.[11] There is also association between age of the patient and anomalous stimulation of the facial nerve.[11] The size of the device can be a significant factor.[11] The flexibility of the Nucleus electrode array may make insertion into the scala tympani easier, the array being free to adopt to the curve of the cochlea, such type of flexibility enhances the potential for kinking and compression.[11]

COCHLEAR IMPLANTATIONS

Cochlear implantation is a surgical method by which the CI device is inserted in the cochlea to stimulate electrically the auditory nerve through its nerve ending in the cochlea.[12] The CI surgery consists of several steps that ranges from cortical mastoidectomy, posterior tympanotomy via facial recess, creation of a large scalp flap, cochleostomy, and insertion of electrode into the scala tympani.[12] Flap design and execution are important and any lapse in the technique may lead to tissue breakdown with resultant loss of the implant. The anatomy of the round window niche and underlying scala tympani should be well known to the operating surgeon before performing the CI surgery to avoid misplacement of electrode.[12] The insertion of electrode array into the scala tympani is an important step that require a high degree of dexterity and technical fineness, specifically in case of partially obstructed or narrow scala tympani. The global complication rate after CI surgery has reduced gradually (from 40 to 4%) due to improvement of surgical techniques with smaller incisions and the use of increasingly miniaturized and biocompatible implants.[13]

COMPLICATIONS OF CI SURGERY

The surgical complications of CI surgery are classified as the criteria from Cohen and Hoffman, which divide the complications into major and minor.[14] Major complications usually need surgical intervention or hospital admission whereas minor complications need observation and outpatient treatment.[14] There are immediate/early complications and long term/late complications are described in CI surgery.[15] The early complications of CI surgery refers to those occurring during the week following surgery.[15] Early postoperative complications include wound infection, skin necrosis, facial palsy, seroma, vertigo, meningitis, and tinnitus.[15] The minor complications of CI surgery are those can be resolved either spontaneously or with conservative treatment and major complications are those need hospital admission, surgery, and later reintervention.[16] The rate of major complications is not usually influenced by etiology of deafness, gender, nor age at cochlear implantation.[17] Although majority of complications are only transient, few remain permanent and require intensive management. Major complications of CI

surgery such as problems during electrode insertion, flap necrosis, facial nerve paralysis, otomastoiditis, postoperative CSF otorrhea, implant sepsis, device failure, non-auditory stimulation, and meningitis are uncommon but considered as serious complications.[5] Minor complications of CI surgery are usually transient peripheral facial nerve paralysis, damage to tympanic membrane, injury to posterior wall of external auditory canal during surgery, hemorrhage, injury to CTN, vertigo, tinnitus, post-operative bleeding, altered sensation in face, facial swelling, otitis media, surgical emphysema, minor electrode mal-position, skin ulceration, granulation tissue formation and bleeding, and pinna ulceration.[17] There may be migration of CI from its bed, particularly when no sutures are used to fix it. In small children, the cranial bone is very thin, making use of transfixion/fixing sutures difficult to perform. Sharp drilling of inferior edge of the implant cavity is an important way to prevent such problem. The commonest minor complications of CI surgery seem to be vertigo followed by acute otitis media/otitis media with effusion, temporary CSF leak and CTN dysfunction.[18] Some report headache, nausea and vomiting, and tinnitus as postoperative complications following CI surgery.[19] Infections, seroma and hematoma are the commonest late complications of CI surgery.[18] Late complications of CI surgery also include extrusion/exposure of device, displacement of electrodes, late device failure, otitis media, and meningitis.[18] The details of complications of CI surgery are given in Table 1.

Table 1: Complications of CI surgery.

Major complications	Minor complications	Non-surgical complications
Flap necrosis	Vertigo/dizziness	Facial stimulation
Meningitis	Tinnitus	Allergic reaction
Defective electrode placement	Labyrinthitis	Device failure
Permanent CTN injury	Tympanic membrane perforation	Abnormal ear anatomy
Facial nerve paralysis	Vestibular neuritis	Pre-existing conditions
Cholesteatoma	Ear canal fenestration	Middle ear/Cochlear fibrosis
	Incision infection	
	Transient CTN injury	
	Transient facial nerve palsy	

Infections

Infection is a major complication of cochlear implantation.[20] The overall rate of infections documented in the literature is from 1.7 to 16.6%.[21] Medical care is beneficial if the infection is a side effect of acute otitis media. Acute otitis media or acute mastoiditis in the implanted ear should be treated similarly to how it is treated in non-implanted ears. Intravenous antibiotics should be given for a few days longer than for ears without implants.[22] However, explantation is always preferred following intensive medical treatment failure, as in cases of *Pseudomonas aeruginosa* infection.[23] To enable for recovery in cases of severe infection, the CI must be removed. It has been shown that certain bacteria can colonize the surface of implant devices and cause biofilm formation; in these cases, explantation is the only way to guarantee infection elimination.[24] Although most of infections associated with CI surgery subside in response to medical treatment, revision surgery becomes needed when skin breaks down.

Facial nerve palsy

Postoperative facial nerve palsy is an uncommon complication. The incidence of the facial nerve injury is often similar in both pediatric and adult ages, 0.58% and 0.55%, respectively.[25] It can occur within two days due to edema or nerve injury, and it can be delayed after three days.[25] There are few theories have been proposed to explain the facial palsy. Reactivation of the herpes virus affecting the facial nerve function is one of them, and it is well documented following tympanomastoid surgery including cochlear implantation.[26] More ever, the surgery with extensive facial nerve manipulation are associated with high chance of viral reactivation.[26] Heat injury of the facial nerve is more likely if extensive drilling is needed to open the round window niche, which happens in cases of cochlear ossification that may accompany meningitis.[27] In these situations, drilling in the round window niche may bring the drill shaft into facial recess and allows heat to be transmitted to the facial nerve.[28] In many cases, there is transient facial nerve palsy seen where the treatment is done with prednisolone and antibiotics.[28] Abnormal facial nerve course is vulnerable for facial nerve injury during cochlear implantation.[29] Careful operative technique, pre-operative imaging, and intraoperative use of facial nerve monitor are helpful to localize and protect the facial neve from injury.[30] During surgery, surgeon should focus not only on avoiding direct injury to the nerve but also on limiting heat transfer to the nerve, which may not even be found during surgery. Surgeon should do copious irrigation while drilling. While drilling in the round window niche, the bur must be angled so that the drill shaft is held away from the floor of the facial recess.[28] One study reported that delayed onset of facial nerve paralysis is common (0.62% versus immediate onset 0.15%) due to nerve exposure during the surgery.[30] There is higher chance of recovery in in delayed onset suggesting that it is a transient event.[30]

CTN injury

The CTN injury seems to be underreported especially in pediatric patients undergoing cochlear implantation.[31] The CTN, a branch of facial nerve is a mixed nerve, which carries sensory and parasympathetic fibers.[32] The sensory part supplies the taste sensation of the anterior two-thirds of ipsilateral side of tongue. The parasympathetic part innervates the submandibular and sublingual salivary gland. CTN injury is a common complication of CI surgery.[32] The number of patients with taste disorders following CTN injury may be less in CI surgery due to under-reporting, because patients are not often questioned about taste disorders post-operatively. During CI surgery, the CTN is exposed and often stretched or sacrificed, as it lacks a bony covering.[33] It is prone for injury during making posterior tympanotomy. Injury of the CTN may cause hypogeusia, ageusia or altered taste sensation of the ipsilateral side of the tongue, and dryness of mouth.[33] An altered sense of taste can occur either in the form of hypogeusia, dysgeusia, or both. One study showed 3% of CTN injury out of the 262 cases of cochlear implantation.[34] Another study of 308 cases operated for cochlear implantation showed 30.8% of CTN injury.[35] The CTN should be protected during cochlear implantation, and patients should be informed of this possible risk prior to surgery.

Damage to electrodes

The most crucial stage of cochlear implantation is insertion of CI electrodes. The excessive manipulation of electrode can cause damage to the electrode.[36] Partial insertions of the electrode may happen that is due to either intracochlear obstruction as in ossifications or fibrosis or from soft tissue friction or resistance during electrode insertion. Since the scala tympani diameter increases toward the base, there may be a greater probability of bending or kinking of the electrode array if an electrode is put against resistance. This increases the risk of injury to the basilar membrane. Postoperative imaging can verify this. The scala media are damaged when an electrode is moved from the scala tympani to the scala vestibuli. This causes the perilymph and endolymph to mix, which results in a loss of the endo-cochlear potential and pre-operative residual hearing.[37] The electrode extrusion or migration of electrode array may happen a long time after surgery. The cause of this complication is variable, but the split bridge technique, tight packing around the cochleostomy window, or canal wall reconstruction should reduce the occurrence of these complications.[38] Electrode insertion can lead to trauma induced hearing loss from mechanical insertion trauma to activation of inflammatory and cell death mechanism. The electrode extrusion or migration of electrode array may occur a long-time following surgery. The cause of this complication is variable, but the split bridge technique, tight packing around the cochleostomy window, or canal wall reconstruction will reduce the occurrence of this complication.[39] Damage from electrode insertion may cause new bone to develop inside the cochlea, which seems to have a detrimental effect on hearing results.

CSF leak

CSF leak occurs frequently at the time of drilling tie down holes during making well for implant. It can also occur after opening of scala tympani in case of modiolar defect or common cavity defect where gushers can happen.[40] Profuse outflow of CSF is called as gusher whereas gentle flow of clear fluid is called oozing.[34] CSF gusher can be managed by packing the common cavity with muscle. If CSF leak still not controlled, ear is closed by plugging the eustachian tube, filling the middle ear and mastoid with fat and cul-de-sac closure. Intraoperative CSF leak from cochleostomy site is a serious complication of cochlear implantation. It can occur due to abnormal communication between SCF and perilymph in the cochlea with possibility of residual CSF fistula and hypothetic higher risk for developing meningitis following surgery.[41] The incidence of CSF leak in CI surgery is reported to be between 1 and 5%.[42]

Vertigo and tinnitus

Vertigo can occur following cochlear implantation.[43] Immediate vertigo or unsteadiness is a common adverse effect of cochlear implantation.[39] One study reported post operative vertigo episodes in 12% cases those underwent CI surgery.[44] Similar to dizziness, it is still unclear what causes tinnitus after CI surgery. Prior research has shown that cochlear implantation can alleviate tinnitus in certain patients.[45,46] Injury to labyrinth during electrode insertion, perilymph loss during surgery, post-operative perilymph fistula, endolymphatic hydrops, foreign body reaction with labyrinth, and electrical stimulation of the labyrinth of the CI are proposed mechanisms for manifesting vertigo due to cochlear implantations.[47] The electrical vestibular stimulation by the CI on the labyrinth is also considered as the cause of the vertigo.[47]

Meningitis

CI recipients are at high risk of developing pneumococcal meningitis. So, it is mandatory for all CI candidates to take pneumococcal vaccination. All children with less than 1 year must receive 3 doses of Pneumococcal conjugate, children more than 5 years should receive pneumococcal polysaccharide vaccine. CI child of more than 2 years who have received pneumococcal conjugate should receive one dose of pneumococcal polysaccharide vaccine.

Device failure

Any implanted device is prone to a considerable risk of failure. Device failure in post operative cochlear implantation period can either be a hard or be a soft device failure.[48] When a hard device fails, the external

and internal devices are completely disconnected, and the device's integrity testing is unsuccessful. On the other hand, a soft device failure is more of a warning when the patient's auditory performance deteriorates or if there are any new symptoms related to implant use. Increases in number of cochlear implantations among patients of sensorineural hearing loss are associated with increased number of explantation and reimplantation. Device failure, whether hard or soft, is often difficult to diagnose. The important cause of hard device failure is either associated with electrode array or receiver stimulator. Any type of trauma in the postoperative time can result in cracks of silicon casing, circuit failure, coil damage, and many more unknown causes.[48] Children with CI may have tendency to fall and get injured, leaving them vulnerable to a higher chance of trauma associated device failure.[49] In case of device failure, reimplantation of CI is often complicated by presence of granulation and fibrous tissue with altered anatomy.[50]

Flap dehiscence

Flap infection with dehiscence is an important major complication of CI surgery. Care should be taken to reduce the complications. In case of anterior base flap, the blood supply arises from the superficial temporal artery and dermal plexus, in the inferior base flap this blood supply comes from retro-auricular and occipital branches of the external carotid artery.[51]Although most infections subside in response to medical treatment, revision surgery only needed when the skin breaks down.

PREVENTION OF COMPLICATIONS

Numerous strategies, including vaccination, intraoperative and postoperative antibiotics, and early treatment of acute otitis media and/or otitis media with effusion, are recommended to minimize infections.[52] Additionally, as some issues may not manifest for years, long-term follow-up is required.[53] There are several techniques used to control CSF leak at cochleostomy. CSF gusher leak can be controlled by sealing with temporalism muscle fascia graft around the electrode array and tissue glue. Lumbar drain can be used to control the cochleostomy gusher. Osmotherapy is an effective means for controlling CSF leak during cochleostomy.[54] One useful method for managing vertigo in people who have had CIs is vestibular rehabilitation. Both vestibular function and residual hearing can benefit from the careful, slow insertion of electrodes and the topical administration of corticosteroids during surgery.[55]

CONCLUSION

CI surgery is a relatively safe surgical procedure for providing effective auditory rehabilitation to patients with severe to profound hearing loss with an acceptable complication. However, few complications of CI surgery are challenging. An awareness of complications of CI surgery is needed among CI surgeons. Surgeons must be trained in cochlear implantation and pay attention to past mistakes in order to lower the complication rates. Manufacturers must also enhance the design and integrity of their devices in order to get positive outcomes, since some issues arise from device failure.

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REFERENCES

1. Swain SK. Hybrid cochlear implant: a scoping review. Int J Otorhinolaryngol Head Neck Surg. 2025;11(1):95-100.
2. Swain SK. Current criteria for selecting cochlear implant in deaf patients: A review. Int J Adv Med. 2022;9:50-5.
3. Chiesa Estomba CM, Rivera Schmitz T, Betances Reinoso FA, Dominguez Collado L, Estevez Garcia M, Lorenzo Lorenzo AI. Complications after cochlear implantation in adult patients. 10-year retrospective analysis of a tertiary academic centre. Auris Nasus Larynx. 2017;44:40-5.
4. Hoffman RA, Cohen NL. Complications of cochlear implant surgery. Ann Otol Rhinol Laryngol. 1995;166:420-22.
5. Raghunandhan S, Mohan Kameswaran RS, Kumar A, Agarwal AK, Hossain MD. A study of complications and morbidity profile in cochlear implantation. Indian J Otolaryngol Head Neck Surg. 2014;66(1):161-8.
6. Zeng FG. Celebrating the one millionth cochlear implant. JASA Express Lett. 2022;2(7):1-8.
7. Venail F, Sicard M, Piron JP, Levi A, Artieres F, Uziel A, et al. Reliability and complications of 500 consecutive cochlear implantations. Arch Otolaryngol Head Neck Surg. 2008;134(12):1276-81.
8. Cohen NL, Hoffman RA, Stroschein M. Medical or surgical complications related to the nucleus multichannel cochlear implant. Ann Otol Rhinol Laryngol Suppl. 1988;135:8-13.
9. Venail F, Sicard M, Piron JP, Levi A, Artieres F, Uziel A, et al. Reliability and complications of 500 consecutive cochlear implantations. Arch Otolaryngol Head Neck Surg. 2008;134:1276-81.
10. Awad AH, Rashad UM, Gamal N, Youssif MA. Surgical complications of cochlear implantation in a tertiary university hospital. Cochlear Implants Int. 2018;19(2):61-6.
11. Moon PK, Qian ZJ, Ahmad IN, Stankovic KM, Chang KW, Cheng AG. Infectious complications following cochlear implant: risk factors, natural history, and management patterns. Otolaryngol Head Neck Surg. 2022;167(4):745-52.
12. Tarabichi O, Jensen M, Hansen MR. Advances in hearing preservation in cochlear implant surgery. Curr Opin Otolaryngol Head Neck Surg. 2021;29(5):385-90.

13. Farinetti A, Gharbia DB, Mancini J, Roman S, Nicollas R, Triglia JM. Cochlear implant complications in 403 patients: comparative study of adults and children and review of the literature. Eur Ann Otorhinolaryngol Head Neck Dis. 2014;131(3):177-82.
14. Cohen NL, Hoffman RA. Complications of cochlear implant surgery in adults and children. Ann Otol Rhinol Laryngol. 1991;100(9):708-11.
15. Bhatia K, Gibbin KP, Nikolopoulos TP, O'Donoghue GM. Surgical complications and their management in a series of 300 consecutive pediatric cochlear implantations. Otol Neurotol. 2004;25(5):730-9.
16. Arnoldner C, Baumgartner WD, Gstoettner W, Hamzavi J. Surgical considerations in cochlear implantation in children and adults: a review of 342 cases in Vienna. Acta Otolaryngol. 2003;125(3):228-34.
17. Green KMJ, Bhatt YM, Saeed SR, Ramsden RT.Complications following adult cochlear implantation: experience in Manchester. J Laryngol Otol. 2004;118(6):417-20.
18. Castro GR, Santiago HCC, de Aguiar RR, de Almeida ABG, Oliveira LSR, Gurgel RQ Cochlear implant complications in a low-income area of Brazil. Rev Assoc Med Bras. 2022;68(5):568-73.
19. Orlando VR, Cruz OLM. Postoperative complications in cochlear implant surgery and their possible risk factors. Braz J Otorhinolaryngol. 2024;90(4):101428.
20. Jinka S, Wase S, Jeyakumar A. Complications of cochlear implants: a MAUDE database study. J Laryngol Otol. 2023;137(11):1267-71.
21. Hopfenspirger HT, Levine SC, Rimell FL. Infectious complications in pediatric cochlear implants. Laryngoscope. 2007;117(10):1825-29.
22. Ramos A, Charlone R, de Miguel I, Valdivielso A, Cuyas JM, Pérez D, Vasallo JR. Complications in cochlear implantation. Acta Otorrinolaringol Esp. 2006;57(3):122-25.
23. Tambyraja RR, Gutman MA, Megerian CA.Cochlear implant complications: utility of federal database in systematic analysis. Arch Otolaryngol Head Neck Surg. 2005;131(3):245-50.
24. Macassey E, Dawes P. Biofilms and their role in otorhinolaryngological disease. J Laryngol Otol. 2008;122(12):1273-78.
25. Swain SK, Samal S, Sahu MC, Debta P. An Unusual Cause of Peripheral Facial Nerve Palsy-A Case Report. Indian J Publ Heal Res Development. 2018;9(12):2357-60.
26. Swain SK, Choudhury J, Acharya S. Herpes zoster oticus among pediatric patients: Our experiences at a tertiary care teaching hospital. Indian J Heal Sci Biomed Res Kleu. 2020;13(3):215-20.
27. Swain SK. Delayed facial nerve paralysis following tympanomastoid surgery. Ann Indian Academy Otorhinolaryngol Head Neck Surg. 2021;5(2):52-6.
28. House JR, Luxford WM. Facial nerve injury in cochlear implantation. Otolaryngol Head Neck Surg. 1993;109:1078-82.
29. Swain SK. Delayed facial nerve paralysis following tympanomastoid surgery. Ann Indian Academy Otorhinolaryngol Head Neck Surg. 2021;5(2):52-6.
30. Alzhrani F, Lenarz T, Teschner M. Facial palsy following cochlear implantation. Eur Arch Otorhinolaryngol. 2016;273(12):4199-207.
31. Swain SK, Acharya S, Shajahan N. Late facial nerve paralysis following tympanomastoid surgery: Our experiences at a tertiary care teaching hospital of Eastern India. Saudi J Otorhinolaryngol Head Neck Surg. 2021;23(4):144-7.
32. Swain SK. Cochlear deformities and its implication in cochlear implantation: a review. Int J Res Med Sci. 2022;10(10):2339-45.
33. Swain SK, Acharya S, Shajahan N. Late facial nerve paralysis following tympanomastoid surgery: Our experiences at a tertiary care teaching hospital of Eastern India. Saudi J Otorhinolaryngol Head Neck Surg. 2021;23(4):144-7.
34. Ajalloueyan M, Amirsalari S, Yousefi A. Report of surgical complications in a series of 262 consecutive pediatric cochlear implantations in Iran. Iran J Pediatr. 2011;21:455-60.
35. Jeppesen J, Faber CE. Surgical complications following cochlear implantation in adults based on a proposed reporting consensus. Acta Otolaryngol. 2013;133(10):1012-21.
36. Brito R, Monteiro TA, Leal AF, Tsuji RK, Pinna MH, Bento RF. Surgical complications in 550 consecutive cochlear implantation. Braz J Otorhinolaryngol. 2012;78:80-5.
37. Swain SK. Hybrid cochlear implant: a scoping review. Int J Otorhinolaryngol Head Neck Surg. 2025;11(1):95-100.
38. Ahmed J, Saqulain G, Khan MI, Kausar M. Complications of cochlear implant surgery: A public implant centre experience. Pak J Med Sci. 2021;37(5):1519-23.
39. Dhanasingh A, Jolly C. An overview of cochlear implant electrode array designs. Hearing Res. 2017;356:93-103.
40. Sennaroglu L. Cochlear implantation in inner ear Malformations-a review article. Cochlear Implants Int. 2010;11:4-41.
41. Terry B, Kelt RE, Jeyakumar A. Delayed complications after cochlear implantation. JAMA Otolaryngol Head Neck Surg. 2015;141(11):1012-17.
42. Brito R, Monteiro TA, Leal AF, Tsuji RK, Pinna MH, Bento RF. Surgical complications in 550 consecutive cochlear implantation. Braz J Otorhinolaryngol. 2012;78(3):80-5.
43. Swain SK. Vertigo following cochlear implantation: A review. Int J Res Med Sci. 2022;10(2):572-7.
44. Filipo R, Patrizi M, La Gamma R, D'Elia C, La Rosa G, Barbara M. Vestibular impairment and cochlear

implantation. Acta Otolaryngol. 2006;126(12):1266-74.
45. Ito J. Tinnitus suppression in cochlear implant patients. Otolaryngol Head Neck Surg. 1997;117(6):701-703.
46. Swain SK. Cochlear implant and tinnitus: A review. Int J Otorhinolaryngol Head Neck Surg. 2021;7(12):1960-4.
47. Tsukada K, Moteki H, Fukuoka H, Iwasaki S, Usami SI. Effects of EAS cochlear implantation surgery on vestibular function. Acta Otolaryngol (Stockh). 2013;133(11):1128-32.
48. Buchman CA, Higgins CA, Cullen R, Pillsbury HC. Revision cochlear implant surgery in adult patients with suspected device malfunction. Otol Neurotol. 2004;25:504-10.
49. Wijaya C, Simões-Franklin C, Glynn F, Walshe P, Reilly R, Viani L. Revision cochlear implantation: the Irish experience. Cochlear Implants Int. 2019;20(6):281-7.
50. Eskander A, Gordon KA, Kadhim L, Papaioannou V, Cushing SL, James AL, et al. Low pediatric cochlear implant failure rate: contributing factors in large-volume practice. Arch Otolaryngol Head Neck Surg. 2011;137(12):1190-6.
51. Telian SA, El-Kashlan HK, Arts HA. Minimizing wound complications in cochlear implant surgery. Am J Otol. 1999;20(3):331-4.
52. Vila PM, Ghogomu NT, Odom-John AR, Hullar TE, Hirose K.Infectious complications of pediatric cochlear implants are highly influenced by otitis media. Int J Pediatr Otorhinolaryngol. 2017;97:76-82.
53. Halawani R, Aldhafeeri A, Alajlan S, Alzhrani F. Complications of post-cochlear implantation in 1027 adults and children. Ann Saudi Med. 2019;39(2):77-81.
54. Loundon N, Leboulanger N, Maillet J, Riggouzzo A, Richard P, Marlin S, et al. Cochlear implant and inner ear malformation: proposal for an hyperosmolar therapy at surgery. Int J Pediat Otorhinolaryngol. 2008;72(4):541-7.
55. Nguyen S, Cloutier F, Philippon D, Côté M, Bussières R, Backous DD. Outcomes review of modern hearing preservation technique in cochlear implant. Auris Nasus Larynx. 2016;43(5):485-8.

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