Surgical Techniques of Cochlear Implantation

Essay

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Contents

List of Tables

List of Figures

List of Abbreviations

Abb.	Meaning
3D	3 dimensions
ABI	Auditory brain stem implant
ABR	Auditory Brainstem Response
ACE	Advanced combination encoder
ADRO	Adaptive Dynamic Range Optimization
AICA	Anterior inferior cerebellar artery
ART	Auditory nerve Response Telemetry
ASSR	Auditory Steady State Response
BOLD	Blood oxygenation level dependent
BOR	brachio-oto-renal síndrome
BSL	Bony spiral lamina
BTE	Behind the ear
CAT	Combined approach technique
CBCT	Cone beam Computed tomography
CDC	Center for Disease Control
CI	Cochlear implant
CIS	Continuous interleaved sampling
CMV	Cytomegalovirus
CSF	Cerebrospinal fluid
CT	Computed tomography
EABR	Electrical auditory brainstem response
EAC	External auditory canal
ECAP	Evoked compound action potentials
ECG	Electrocardiography
EEG	Electroencephalography
EEG	Electroencephalography
EMA	Endomeatal approach
ERG	Electroretinography
fMRI	Functional magnetic resonance imaging
FSE-MRI	Fast Spin Echo magnetic resonance imaging
HL	Hearing level
HRCT	High resolution Computed tomography

Abb.	Meaning
IAC	Internal auditory canal
IAM	Internal auditory meatus
IHC	Inner hair cells
IP	Incomplete partition
ITMAIS	Infant Toddler Meaningful Auditory Integration Scale
LNT	Lexical Neighbor test
LO	Labyrinthitis ossificans
LOC	Lateral olivocochlear bundle
MCF	Middle cranial fossa
Med-El	Medical Electronic Corporation
MEG	Magnetoencephalography
MOC	Medial olivocochlear bundle
MPEAK	Multipeak
MPTA	Mastoidectomy-posterior tympanotomy approach
MRI	Magnetic resonance imaging
MSCT	Multislice computed tomography
NICU	neonatal intensive care unit
NMNPT	Non-mastoidectomy non-posterior tympanotomy technique
NRI	Neural Response Imaging
NRT	Neural Response Telemetry
OHC	Outer hair cells
PET	Positron emission tomography
PP	Postis posterior
RWN	Round window niche
SBC	Standard bony promontory cochleostomy
SD	Standard deviation
SMA	Suprameatal approach
SNHL	Sensory neural hearing loss
SPEAK	Spectral peak
VSS	Vessel Sealing System

Introduction

Cochlear implantation has proved to be an excellent therapy for patients with severe to profound sensorineural hearing loss. It restores the ability to hear sound and to understand speech to various degrees **(Marel et al., 2011).** With today's technology and the demonstrated success of cochlear implantation, candidacy criteria have greatly widened **(Chen et al., 2009).**

In cochlear implant surgery, there are three principal approaches: the classic approach, uses the facial recess, the suprameatal approach, does not require mastoidectomy and uses the creation of a tunnel over the facial nerve to enter the middle ear, and the endomeatal approach which is based on the completion of a groove in the posterior wall of external auditory canal **(Zernotti et al., 2012).**

The classical approach uses the facial recess for passage of electrodes from the mastoidectomy into the middle ear. This technique requires a simple mastoidectomy and a posterior tympanotomy. Access to the middle ear is narrow at this point and requires precision and experience, since the presence of the facial nerve requires certain risks to be assumed. Critics of the technique emphasise this point, arguing that this access can be

bypassed, thus avoiding the proximity of the facial nerve and its possible complications **(Zernotti et al., 2012).**

Alternative techniques to classic mastoidectomy and posterior tympanotomy for cochlear implantation have already been described but their main drawbacks result in either: the risk of an electrode extrusion through the skin as the groove is drilled into the auditory canal or the risk of a facial nerve injury as the tunnel is drilled blindly into the posterior canal wall **(Guevara et al., 2010).**

With a common cavity malformation, the transmastoid labyrinthotomy approach to the common cavity is an effective and simple technique for placing the electrode array **(Zarandy, 2008).** Percutaneous cochlear implant surgery consists of a single drill path from the lateral mastoid to the cochlea via the facial recess cortex.Within all fields of surgery, there has been a push toward minimizing the invasiveness of procedures image-guided surgical systems (IGS) **(Labadie et al., 2008).**

The combined approach technique (CAT) is a variation of the classical technique, it combines a transcanal approach to cochleostomy with a reduced posterior tympanotomy for insertion of electrodes, a safe alternative approach in cochlear implant surgery, with no related major complications and fewer cases of electrode migration when compared with the classical

posterior tympanotomy approach. These findings encourage the use of the transcanal route to cochleostomy as an alternative approach option **(Lavinsky et al., 2012).**

Despite the fact that the transmastoid facial recess approach continues to be the gold standard and most commonly utilized worldwide for cochlear implant (CI) surgery, other techniques have been developed and described in the literature. While many of them are employed when anatomical constraints require nontraditional approaches such as a small mastoid cavity, make the facial recess approach more difficult, others are used depending on the preference, comfort level, and specific training of the surgeon. While these alternative techniques are important additions to any otologist, it is paramount that CI surgery remain safe and effective while minimizing complications **(Zeitler et al., 2010).**

Aim of the Work

To review the literature regarding the different surgical techniques of cochlear implantation, highlighting the advantages and disadvantages of each technique.

Surgical Anatomy

Knowledge about the anatomy and physiology of the auditory system is a prerequisite for understanding not only the normal function of the auditory system, but also for understanding the fact that changes in function may result from surgical manipulations **(Moller, 2011).**

Mastoid air cell system

A portion of the mastoid process is pneumatized to form numerous mastoid air cells of inconstant size and number. Although anteriosuperiorly they are large, irregular, and air containing, the inferior-most cells are often rather small and may even contain marrow. The tympanic antrum is the large irregular air cavity lined by mucous membrane beginning at the aditus and extending posteriorly (Fig. 1) **(Nayak, 2001).** With cochlear implant surgery it is necessary to remove the cells from part of the mastoid bone to provide space for the receiver-stimulator and lead wire assembly. Air cells must also be removed to expose the posterior wall of the middle ear for access to the round window and basal turn of the cochlea for the insertion of the electrode array through a posterior tympanotomy **(Clark, 2003).**