Comparative Study of the effect of equipotent doses of Sevoflorane and Propofol on evoked stapedius reflex threshold (ESRT) and evoked compound action potential (ECAP) during cochlear implantation in children

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IN
ANESTHESIOLOGY
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μmol/L:	Micromol per litre
ASA:	American society of anesthesiology
BIS:	Bispectral index
BOA :	Behavioral observation audiometry
CBF:	Cerebral blood flow
CI:	Cochlear Implant
C-level:	The maximum comfortable level
CNS:	Central nervous system
CO_2:	Carbon dioxide gas
CSF:	Cerebrospinal fluid
Db:	Decibel
EABR:	Electrically evoked auditory brainstem response
ECAP:	Evoked compound action potential
ECT:	Electroconvulsive therapy
EEG:	Electroencephalogram
EMG:	Electromyography
ESRT:	electrically evoked stapedius reflex threshold
$ETCO_2$:	End tidal carbon dioxide
FDA:	Food and Drug Administration
GABA:	Gamma amino butyric acid.
HR:	Heart rate
Hz:	Hertz
ICU:	Intensive care unit

IOFNM: Intraoperative facial nerve monitoring

IV: Intravenous.

LMA: laryngeal mask airway

MAC: Mininum alveolar concentration

MAP: Mean arterial blood pressure

MCL Maximum comfort level of hearing

MEP: Motor evoked potentials.

MLAEP: Mid latency auditory evoked potentials

NRT: Neural Response Telemetry

$PaCO_2$ Arterial tension of CO_2

SaO_2: Arterial oxygen saturation

SEP's: Somatosensory evoked potentials.

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Abstract

Background: Cochlear implantation is the treatment of choice for children and adults with severe-to-profound hearing loss. Acoustically evoked stapedius reflex (SR) is important for assessment of the individual dynamic spectrum of the implanted speech process and values measured intraoperatively are influenced by anesthetics Hence, the technique of anesthesia plays a crucial role in success of cochlear implant surgery. The study was designed to compare the effects of equipotent doses of propofol and sevoflurane on the intraoperative evoked stapedius reflex threshold (ESRT) and evoked action potential (ECAP) during cochlear implantation in children and to evaluate the relation between intraoperative ESRT & ECAP and the postoperative measured maximum comfortable level & threshold level.

Methods: The current study included 30 children who were scheduled for cochlear implantation , aged 4-12 years old with ASA I-II. Patients were divided into two groups (Propofol-group) & (Sevo-group) 15 of each. Under general anesthesia ,standard monitors were applied, propofol and Sevoflurane dosages were adjusted to maintain target BIS levels between 40-60 . intra-operative measurements are HR,MAP, BIS,ESRT and ECAP values at the electrodes 20,15,5.

Results: There was statistically significant differences between both groups as regard the differences between Intraoperative stapedius reflex threshold (ESRT) values & postoperative C-level at the three electrodes 20, 15, 5. it was obvious that the differences in the Sevo -group was higher than that of the Propofol -group (p value < 0.5). but there were no statistically significant differences between the Intraoperative ECAP and the postoperative C-level values at the same three electrodes either in both groups(p value > 0.05) .

Conclusion: The study revealed that the use of BIS monitoring of great value especially during stapedius reflex measurements values where we need a defined level of anaesthesia. Sevo has high suppressive effect on intraoperative ESRT that could lead to false high values of the post operative predictive C-level which carry the risk of post operative implant rejection. Propofol has minimal suppressive effect on the intra-operative ESRT and so preferred for measurement of the ESRT. ECAP is not affect by the anesthetics

Key words:

cochlear implantation –propofol- stapedius reflex-sevoflurane –BIS.

INTRODUCTION

Helen Keller once said, "Loss of vision means losing contact with things, but loss of hearing means losing contact with people." At any age, difficulty in hearing can lead to social isolation, frustration and emotional problems. Everything from making friends, keeping in touch with family, being happy, getting an education, and finding a job can be affected by a hearing loss. The effect can also have a wider impact on all the family and on the society as a whole. In the past, there was little anyone could offer to alleviate profound sensory hearing loss and the deaf person had to learn to cope as normally as possible in the absence of hearing (***Gantz et al, 1993).***

The cochlear implant has radically changed the outlook for profoundly deaf adults and children. The cochlear implant can provide sufficient hearing sensations to enable most deafened persons to continue communicating using speech and can provide the opportunity for children born deaf or deafened early in life to use speech as their primary means of communication ***(Christiansen& Leigh, 2002)***.

Cochlear implants bypass the transduction mechanisms of the cochlea by electrically stimulating the auditory nerve directly, thus providing a miraculous escape from a terrible disability ***(Wald& Knutson, 2000)***.

Cochlear implants stimulate the auditory nerve electrically to allow hearing in individuals with sensorineural deafness. The appropriate range of implant stimulation is guided by various auditory evoked responses that can be measured during cochlear implant surgery and postoperatively. Intraoperative measurements are generally favored in children because they eliminate the need for patient cooperation. The intraoperative electrically evoked stapedius reflex threshold (ESRT) and evoked compound action potential (ECAP) are used to guide implant settings in many centers. ***(Gordon et al, 2004).***

The stapedius reflex, an autonomic reflex that protects the ear from the effects of loud noise, is evoked electrically during cochlear implantation to determine the loudest sound that can be tolerated without causing discomfort (the maximum comfort level, MCL). An MCL set too high causes discomfort that may adversely affect the child's ability to adapt to the cochlear implant.

The ECAP is used to determine the hearing threshold, the minimum acoustic stimulus perceived as sound; if set too high, normal levels of speech may be inaudible thereby under-utilizing the ability of the implant to enable hearing. Adjusting implant stimulation limits to the patient's individual dynamic range (the range between the hearing threshold and the MCL) is essential for the successful use of a cochlear implant. ***(Mason, 2004)***

An ideal anesthetic technique for cochlear implant surgery is one that has no effect on the measured evoked auditory responses. It has been suggested that some general anesthetics can elevate the threshold of the electrically or acoustically elicited stapedius reflex. ***(Crawford et al, 2009)***.

Aim of study:

The study was designed to compare the effects of equipotent anesthetic doses (adjusted by the bispectral index (BIS) to maintain it constant 40- 60) for the propofol and the sevoflurane on the intra-operatively ESRT and ECAP during cochlear implantation in children and to evaluate the relation between intra-operatively ESRT & ECAP and the post-operative measured maximum comfortable level & threshold level.

Historical view

The medical understanding of cochlear implants is both a history of past success and a vision of future success. In an interview with one of the Dutch implant surgeons, he said "It will come when no one can stop it; eventually all deaf children will have cochlear implants though I don't know if I'll be around to see it".

In February 1957 a totally deaf person about to be operated on begged Paris' otologist Charles Eyries to find a solution to his hearing impairment, however minimal result &explanted upon patient request. ***(Djourno, 1957).***

In 1961 a Los Angeles otologist, William House, made a second attempt. House's implant was different from that used in Paris but it failed also.

The most significant work had been that of an Australian otologist, Graeme Clark. Influenced in particular by the work of Simmons, and like Simmons and Chouard, Clark was convinced that for speech to be made perceptible a multichannel device was needed. After a decade of work, in 1978 Clark felt able to try out his prototype on a volunteer. A 48 year old man, who had been suffering from deafness due to an accident two years before, read about Clark's work in a magazine, approached him and eventually became his first implantee ***(Epstein, 1989)***.

In October 1983, 3M sought premarket approval from the Food and Drug Administration (FDA) for its device, submitting data on more than 350 patients implanted. The FDA decided that the device was safe and that it provided access to environmental sounds. For some patients it "may aid" with lip reading. In October 1984 the 3M/House device became the first cochlear implant to be approved for use in deaf adults (age 18 or over). FDA approval of the Nucleus device, based on Clark's design, followed 12 months later. The numbers implanted, had grown from less than 100 worldwide in 1978 to nearly 500 by 1984, and were set to grow more rapidly as devices could be marketed and used, backed by the authority of FDA approval ***(House,1985)***.

Chouard in France was the first to be convinced that "the most successful results will be obtained on the youngest patients" and in August 1977 he implanted his first children, aged 10 and 14. Plans were already being laid to implant children as young as 6-8 years of age. Fellow professionals greeted this step with surprise and concern, regarding it as premature, though little was said in public. In the USA, House started implanting children in 1980. Despite profound disagreement regarding the appropriateness of this step, once more, objections arose from neurophysiologists. By the early 1980s the idea of implanting deaf children was securely on the professional agenda ***(Pickstone, 1992).***

Few clinicians seem to doubt that each step taken has been a step forwards. An exception is William House, who has recently argued that consensus favoring the multiple electrode system (in particular that of Nucleus) over his own single electrode system was unjustified. House also deals with criticism of his first work with children in the early 1980s and in particular the claim that it was unwarranted and unethical ***(House WF, 1995)***.

The rapid advancement of CI technologies, coupled with new findings from basic science laboratories in the last 20 years, has placed CI firmly in mainstream medicine. CI has proved to impact a great deal of positive effects on a patients' quality of life. As selection criteria are continued to be relaxed, the number of implants received is expected to grow rapidly during the next decade. It is the physician’s responsibility as a patient’s advocate to bring this awareness to the public, government agencies, and health maintenance organizations, and to work with device manufacturers to bring down the cost ***(Nancy et al, 2003)***.

ANATOMY OF THE INTERNAL EAR

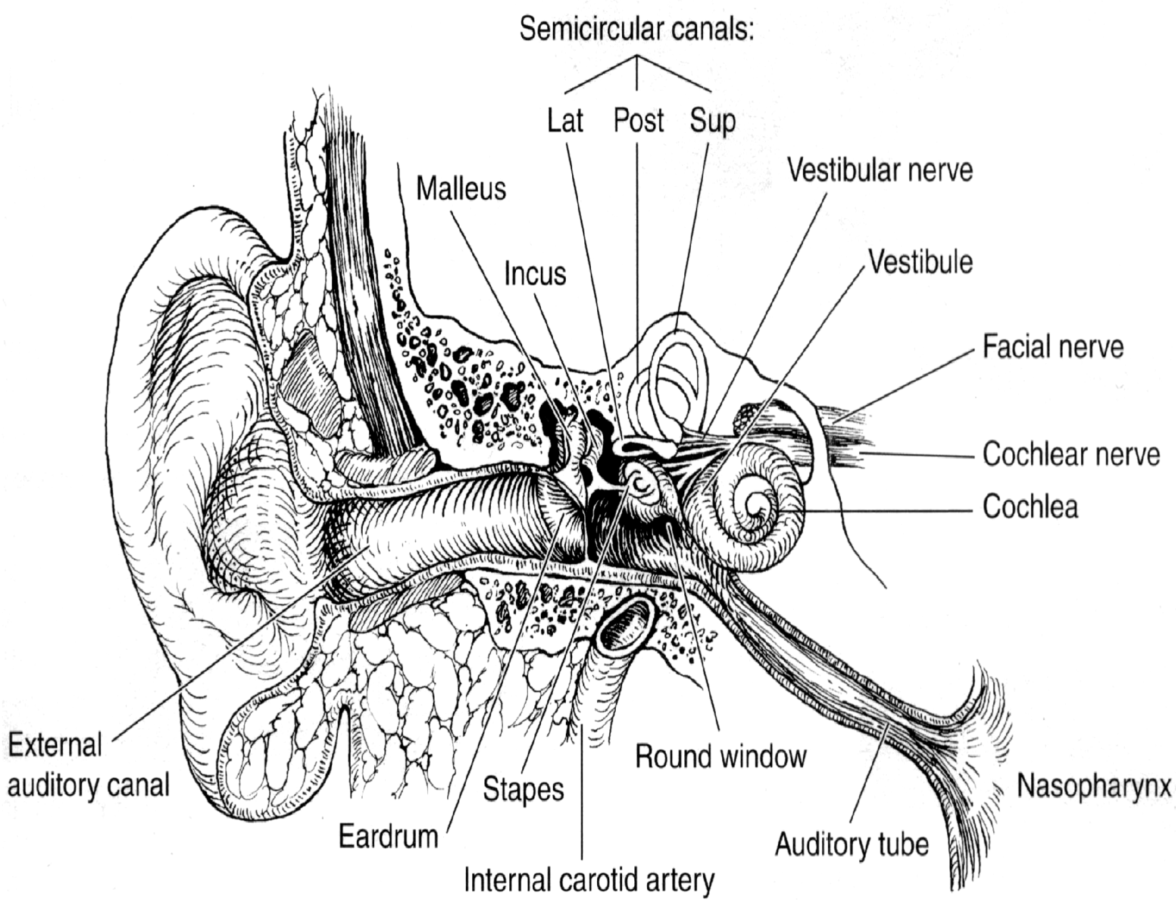

Fig. (1): *The human ear. To make the relationships clear the cochlea has been turned slightly and middle ear muscles have been omitted. Sup. Superior; post, posterior; Lat, lateral* ***(Ganong, 1999)***

The internal ear is buried in the petrous part of the temporal bone and is practically full adult size at birth. It consists of a complex series of connected cavities. The osseous (bony) labyrinth, within which lies a correspondingly complex fluid-filled sac, named the membranous labyrinth. The fluid it contains is endolymph (the only extracellular fluid in the body which is rich in Potassium and low in Sodium) and, because the membranous labyrinth is smaller than the osseous, its walls are not all pressed tightly against the bone but are mostly separated from it by another fluid, perilymph (high in Sodium and low in