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A comparison between neural response telemetry via cochleostomy or the round window approach in cochlear implantation

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Abstract

There are two techniques for cochlear implant (CI) electrode placement: cochleostomy and the round window (RW) approach.

Objective: This study aims to compare neural response telemetry (NRT) results immediately after surgery to check for possible differences on auditory nerve stimulation between these two techniques.

Materials and Methods: This is a prospective cross-sectional study. Twenty-three patients were enrolled. Six patients underwent surgery by cochleostomy and 17 had it through the RW approach.

Results: Mean charge units (MCU) for high frequency sounds: patients submitted to the RW approach had a mean value of 190.4 (± 29.2) while cochleostomy patients averaged 187.8 (± 32.7); $p = 0.71$. MCU for mid frequency sounds: patients submitted to the RW approach had a mean value of 192.5 (± 22) while cochleostomy patients averaged 178.5 (± 18.5); $p = 0.23$. MCU for low frequency sounds: patients submitted to the RW approach had a mean value of 183.3 (± 25) while cochleostomy patients averaged 163.8 (± 19.3); $p = 0.19$.

Conclusion: This study showed no differences in the action potential of the distal portion of the auditory nerve in patients with multichannel cochlear implants submitted to surgery by cochleostomy or through the RW approach, using the implant itself to generate stimuli and record responses. Both techniques equally stimulate the cochlear nerve. Therefore, the choice of approach can be made based on the surgeon's own preference and experience.

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INTRODUCTION

Brazil is estimated to have about 347,000 deaf individuals, many of them with indications for a cochlear implant. For patients with little cochlear reserve who can not achieve good sound discrimination even with sound amplification, the cochlear implant (CI) is one option for their rehabilitation[1]. The cochlear implant brings about an improvement in hearing quality and improvements in speech perception and production, rendering a permanent and ascending quality-of-life gain in many aspects - such as self-sufficiency and socialization[2-5]. It is estimated that since the 70's until today, there are 400 thousand implanted patients[6].

Cochlear implants partially replace the cochlea by turning sound into electrical signals[7]. The survival of enough neural structures in the cochlear nerve allows the transmission of electric stimuli to the cerebral cortex.

The surgical implantation procedure via the transmastoid approach has been well standardized. Cochleostomy was first described in the 1980s[8]. There are two techniques to place cochlear implants: via a cochleostomy, in which the promontory is drilled to fixate the implant, or via the round window (RW). Less drilling is required in the RW technique, thus reducing trauma, loss of perilymph, and bone powder on the tympanic scale[9]. Preservation of residual hearing has been viable and beneficial due to the combination of electrical and acoustic stimulation, but it requires non-traumatic insertion of the electrode to minimize damage to inner ear structures and enable lesser neural tissue degeneration[6].

There are different ways to perform objective measurements on the auditory nerves of cochlear implant users from the electrical stimulation of the auditory system such as auditory brainstem response (ABR), middle latency response, late potentials, and stapedial reflexes[1]. Neural response telemetry (NRT) is a test used to measure electrically evoked compound action potentials (ECAP) during surgery or postoperatively in implanted patients. This is an important test used to accurately monitor external and internal hardware function, and assess cochlear stimulation through neural responses[10].

This is a prospective cross-sectional study aimed at comparing neural response telemetry in the immediate postoperative care of 23 patients of both genders with cochlear implants placed through cochleostomy or the RW approach to verify whether the choice of implantation procedure produces differences in auditory nerve stimulation.

MATERIALS AND METHODS

This study was approved by the Medical Ethics Committee on Research with Human Subjects and given permit nº 004/2010. This study complied with the standards defined in Resolution 196/96 issued by the Ministry of Health.

Twenty-three patients, seven males and 16 females, were enrolled in this study. Six patients underwent implantation via cochleostomy and 17 via the round window approach. All patients were implanted the same device made by the Cochlear Corporation. The procedures were performed by the same surgeon.

The multichannel cochlear implants used in this study have 22 electrodes placed on the cochlea. The electrodes are numbered from one to twenty-two, 22 being the one placed more apically. These electrodes were grouped the following way: 1-7 high frequency sounds, 8-15 mid-frequency sounds, 16-22 low frequency sounds. This division was needed because during NRT not always we could get neural responses on one same electrode without changing the assessment parameters, and thus we left it for the software program to randomly choose within the groups which electrodes would be analyzed. Electrodes were split by ranges into high, mid, and low frequency groups for the purposes of statistical calculation, as not all electrodes were analyzed individually.

The surgical technique employed to place cochlear implants consists of the following steps: 1. General anesthesia for pediatric patients and local anesthesia plus sedation for adult patients; 2. Retroauricular incision of about three centimeters; 3. Dissection of subcutaneous tissue and muscle plane; 4. Y-shaped periosteal flap; 5. Shift periosteum from the skullcap at the site of implantation of the internal unit; 6. Mastoidectomy; 7. Posterior tympanotomy; 8. Perform cochleostomy in the anterior inferior area of the RW in cases where cochleostomy was used as the implantation approach; drill the upper lip of the round window and open it with a probe; 9. Insert electrode beam; 10. Perform neural response telemetry; and 11. Close the planes of muscle and skin tissue using vicryl 3-0.

All patients were discharged on the same day of surgery and had compressive dressings on for two days. Amoxicillin and clavulanic acid were administered for 10 days. Implants were activated 30 days after surgery.

The Custom Sound AutoNRT measurement system comprises the following elements: 1. A computer with Windows Vista Home Basic, Intel® Pentium® Dual processor; 2. Software version Custom Sound EP 2,0 (2.0.4.7298) and 3,2 (3.2.3855); 3. Programming interface - POD; 4. Speech processor - Freedom sound processor and *headset* SPrint; 5. Freedom Implant (Contour Advance). The NRT software was developed by the Engineering Department at the *Cochlear Corporation*[11].

A computer equipped with programming interface is used to stimulate specific electrodes inside the cochlea. A series of pulses of information bidirectional communication using encoded radio frequency is transmitted from the Freedom processor interface through an external antenna placed inside a sterile bag placed on the patient's