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TOPICS IN PEDIATRICS

Fitting parameters for cochlear implant☆

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Abstract Programming an implant in a patient follows a standardized and individualized protocol. Although this process uses common parameters in most cases, in a percentage of cochlear implant users, for some reason, it is not possible to establish appropriate levels of stimulation. In these patients, the audiologist has to make adjustments in some parameters, such as a change in the strategy, stimulation rate, pulse width, in order to obtain the expected performance.

PALABRAS CLAVE
Implante coclear;
Programación de implante coclear;
Ancho de pulso;
Estimulación facial

Parámetros de programación del implante coclear

Resumen La programación de un paciente implantado resulta un proceso inicialmente estandarizado, pero que debe individualizarse para cada caso. En la mayoría de las ocasiones, dicho proceso implica el establecimiento de parámetros comunes; sin embargo, existe un porcentaje de usuarios en los que por alguna circunstancia no es posible establecer niveles adecuados de estimulación, por lo que el médico audiólogo tiene que realizar ajustes en parámetros especiales como son: cambio de estrategia, tasa de estimulación, ancho de pulso, con el fin de obtener undesempeño auditivo de acuerdo a lo esperado.

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1. Introduction

A cochlear implant (CI) is an electronic device that provides a hearing sensation and replaces the function of the damaged or absent ciliated cells in the inner ear; it provides a previously processed electrical stimulus, which is distributed in a tonotopic way to the nerve fibers that emerge from the cochlea.[1]

Currently, after an experience of more than 60,000 cochlear implants worldwide, this technique can be considered as non-experimental since its efficacy in the treatment of profound hearing loss has been demonstrated.[2]

In the Mexican health care system, the cochlear implant has become an efficient and available treatment for the population. When placed in the earlier stages of life, it enables the hearing sensation and language in pediatric patients. For this reason, it is of utmost importance that the health personnel are familiar with this device and its operation.

The cochlear implant provides functional hearing and improves the levels of understanding of the language in the majority of patients with postlingual hearing loss, and allows the acquisition of spoken language in children with pre-lingual hearing loss, an improvement in the quality of life of patients with severe and profound hearing loss.

Programming an implant in a patient follows a standardized protocol. Moreover, it must be performed in an individualized manner for each patient, in order to establish the range in which it is possible to detect and discriminate the sounds of the human voice regarding the spoken language. However, in a percentage of cochlear implant users, for some reason, it is not possible to establish adequate levels of stimulation, thus remaining at sub-optimal levels of hearing. In these patients, the audiologist has to make adjustments in some parameters, such as change of strategy, stimulation rate, and the width of the pulse, among others.

2. Epidemiology

The World Health Organization (WHO) defines a disabling hearing loss as the one consisting of average audiometric thresholds greater than 40 dB HL, because of its impact on the development of spoken language, cognition, behavior and academic performance. In 2012, the WHO reported that there are nearly 275 million people around the world with moderate or profound hearing impairment, of which 32 million are children under 15 years of age. Two-thirds of these patients live in developing countries and 25% of them suffer from hearing loss since childhood.[3]

Every year, 5,000 children with bilateral permanent hearing loss are born in the United States. An incidence between 1/900 and 1/2,500 cases of permanent bilateral congenital hearing loss is estimated in its different grades: moderate, severe or profound.[4]

In Mexico, a study by the National Institute of Statistics and Geography (INEGI) in 2000 revealed that 2.8/1000 people have disabling hearing alterations; thus, 200,000 total hearing impaired patients are estimated, of whom 10% may be candidates for cochlear implantation.[1]

According to data from the annual survey of the European Association of Cochlear Implant users, in 2009 there were 7500 users of this device in Spain, of whom 4.412 were children and 3.888 were adults.[5]

In Mexico, during the last five years, the program of cochlear implant has had a major boost. In 2004, 520 patients were implanted. This number increased to 1500 patients in 2006.[1]

3. Cochlear implant

Every CI has the following common features:

- A microphone to capture sound and transform it into electric signals
- A sound processor that encodes the electric signals with a battery
- A transmission system or coil that communicates the processor with the implanted internal components
- A receptor-stimulator antenna
- A flexible electrode array that is surgically implanted in the cochlea
- The microphone, the sound processor, the batteries unit, and the transmission coil form the external parts of the CI system; the receptor/stimulator device and the electrode array constitute the internal parts[2,6]

4. Programming of the cochlear implant

The main objective of the programming is the calibration of the CI to restore the hearing within the range of the human voice. Therefore, it is necessary to establish the parameters through which the device will transform the acoustic signals into electric signals, which will be sent to the auditory system for their processing. To achieve the latter, it is essential to select the mode and the strategy of stimulation, activation of microphones, rate of stimulation, number of maximum volumes, sensitivity and activation of the different electrodes, among other parameters.[2]

A strategy of stimulation is defined as a set of rules that delimit the form in which the sound processor analyzes the acoustic signals and encodes them for their delivery to the CI. There are large differences in the processing of the signal used by the strategies of stimulation of the latest systems of CI; some clinical trials show that the performance is similar between the existing brands. After the selection of the strategy, the creation of the auditory map, which is basically determined by the electrical stimulation threshold and the comfort threshold, should be followed.[2]

An auditory map is an individualized hearing program that is created and stored in the sound processor of the implant; the software consists of a graphical representation of the electrodes in the implant displayed on a computer screen in progressive order. The electrodes correspond to the sequential order in which they are placed inside the cochlea, but not necessarily in the order in which they are stimulated, since it can be modified[1,7–9](Figure 1).