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ORIGINAL ARTICLE

Improvement of the video analysis method for the evaluation of communication skills in deaf children with complex needs

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ABSTRACT

Several papers report important benefits from cochlear implants for deaf children with complex needs but these improvements are difficult to assess with standard tests. The communication strategies of deaf children with complex needs are comparable to those of very young children without comorbidities because both are in a preverbal stage of communication. For this reason we propose a new use of video analysis in deaf children with associated disabilities. The set-up of the recording is the same as the standard method and 20 communication turns are evaluated. The adult stays in front of the child at eye level (especially if a child has a visual impairment). The abilities and progress of the children are evaluated in the standard four areas: turn-taking, autonomy, awareness and eye contact. Non-verbal behaviours are examined. When it is possible to evaluate the category of the eye contact, the most important parameter to take is the adequacy of the use of this ability. For deaf children with complex needs, it is very important to add to the standard parameters the analysis of the maternal communicative style. In conclusion, video analysis can be a useful tool of evaluation when dealing with deaf children with associated disabilities even if not applied in its standard form.

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Introduction

Approximately 40% of children affected by hearing loss show one or more associated disabilities.[1–4] This difference in epidemiology is due to a difficult precise diagnosis and definition of the additional comorbidities. The definition of these disorders depends on the type, frequency, aetiology and age at which they arise. For instance, developmental delay and mild neurological deficits or autistic spectrum disorders (ASD) are often diagnosed after age 2 years whereas sensorineural hearing loss (SNHL) is frequently diagnosed at birth as a result of audiological neonatal hearing screening.[2,5] Moreover, the epidemiology changes in relation to additional disabilities in the deaf population and in relation to deafness in the population with additional disabilities.

Ophthalmic problems and visual impairments affect 40% to 60%[3,6] of deaf patients; neurodevelopmental disorders affect about the 50%[2] of deaf children while 47% have speech and language disorders.[3] It is necessary to point out that, often, the same individual shows more than one associated disability in addition to deafness.[1,2,7]

More important is the aetiology of the deafness; the prevalence of the disabilities is greater in patients with an hereditary syndrome, or a history of intrauterine infections and pre/perinatal disorders.[2] The prevalence of hearing loss in cerebral palsy is estimated to be between 4% and 40%,[8] depending on the degree of hearing loss examined and on the cause of the cerebral palsy, whereas in children with autistic spectrum disorders the prevalence of the deafness is from 1.5% to 4.2% (depending on the age of the patients).[4,9]

In deaf people, the difficulty in identifying an exact percentage of associated disabilities is also due to the different degree of hearing loss considered in the different studies. Some authors take into consideration all degrees of hearing loss but others only consider those with severe to profound hearing thresholds.[3] In the case of patients with severe to profound hearing loss, a cochlear implant is a solution that can help to provide a sense of sound and support speech and language development. Initially, however, children with comorbidities were excluded from surgery.

Recent studies report that deaf people with associated disabilities can benefit from cochlear implants;

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however, outcomes may vary depending on the type, the degree and the number of the associated disabilities.[4,10] The presence of brain and inner ear abnormalities influences the outcomes, specifically gliotic injuries, disorders of the white matter of the brain; stenosis of the internal auditory canal and a common cavity may contribute to poor outcomes.[11]

It is important to highlight how the severity of the disability leads to different outcomes in children with cochlear implants. Filipo et al. affirm that a good outcome is shown in post-lingual deaf-blind adults who have received a cochlear implant;[10] similar results are seen for children with a cochlear implant and isolated motor developmental delay,[12] mild developmental delay, or behavioural, visual, orofacial and vocal tract disorders.[5,13]

Holt and Kirk report that, thanks to cochlear implants, children with mild cognitive delay have more improvement in perception/reception of speech than people with cochlear implants without this disability.[14] On the other hand, people with more severe developmental delay perform less well. Cognitive disabilities are the strongest predictor of the outcomes for these patients.[5,13]

The number, degree and type of disability influences the outcome: the more comorbidities involved the poorer is the outcome.[13]

Eze et al. assert that children with cochlear implants and developmental disability make improvements in speech production, recognition, perception and in auditory skills but less improvement and slower progress than implanted children without disabilities.[5] Martini et al. agree that, with regard to Italian children with cochlear implants, patients with multiple disabilities make improvements in speech and communication but less well and at a slower rate than children without disabilities.[15]

Several papers report that the more important benefits of the cochlear implant in deaf people with associated disabilities, concern life quality, social and relationship skills (better self-confidence, behaviour, independence and social integration) and environmental awareness, but these improvements are difficult to assess with standard tests.[5,7,10,15–17]

Difficulty in using standard tests varies according to the type of associated disability. Children with visual impairment are not able to use lip-reading and it is not possible to show them illustrated material. Patients with severe motor delay have normal cognition but physical difficulties (this particularly affects their ability to point and to articulate). Children with cerebral palsy or ASD may have both cognitive and physical disabilities.[5] The evaluation of these children has to be made through various audiometric tests, speech and language tests and questionnaires, but there are no standardized protocols.

Usually, speech evaluation in children with cochlear implants consists of four categories (without lip-reading and at conversational voice intensity level): detection, discrimination, identification and recognition. These four categories are evaluated progressively from the easiest (detection) to the most difficult (recognition) level. Detection is the presence or the absence of the sound; discrimination is the ability to decide if two sounds are different or identical; identification is the ability to recognize one sound in a close-set whereas recognition is the same task but in an open-set.[18]

In all children, even the newborn, it is easy to evaluate the level of detection through the reaction of the child to a sound (e.g. smiling, crying, facial expression or turning to the sound source). The other categories, from discrimination to recognition, require more complex skills. Children without spoken language and severe visual impairment or severe neurodevelopmental disorder cannot perform standard tests. It is only through the video-analysis evaluation tool that we can analyse the performance of children with complex needs.

This article proposes a new approach to video analysis which aims at assessing the global benefits offered by cochlear implants (CI) or hearing aids in patients with complex needs.

Video analysis

Video analysis is a method for monitoring and measuring improvements in very young children who are at the preverbal stage at implantation (or at the fitting of hearing aids) where standard tests cannot be applied. The method is based on the evaluation of sequential stages that infants go through before achieving verbal communication. In particular, these stages are characterized by shared attention, conversational style, eye contact, turn-taking, auditory awareness and processing skills. It is known that these preverbal measures are predictive of linguistic and speech performance (in particular speech discrimination and intelligibility outcomes) in those children with cochlear implants or hearing aids who have been assessed regularly over a number of years.[19,20]

The video analysis is a video recording, lasting 5–10 min, of the interaction between child and parent or other known adult. This method allows for the transcription and quantification of preverbal skills, the evaluation of development and the level of babbling.

Furthermore, it is a helpful tool for counselling and demonstrating to parents how they can recognize their child's potential and build their communication skills.

Overall, video analysis is a good tool for an early, personalized and efficient educational intervention as it identifies outcome prognostic parameters in children with cochlear implants or hearing aids.

Use of video analysis for deaf children with complex needs

In this article we propose a new use of video analysis for severe to profoundly deaf children with complex needs. The use of this tool is possible because these children can be compared to very young children in a preverbal stage of communication. Due to the complexity of these patients, it has been necessary to make some modifications to the standard method.

Video recording procedures

The set-up of the recording is very important. The child should be placed on a chair or sat on a carpet in a quiet, comfortable and bright room. For children with motor difficulties, it is essential for them to use their own seat (sitting with support, wheelchair or highchair). It is also very important that the two speakers stay at eye level. The adult must stay in front of a child who is visually impaired about one metre away. Attention has to be paid to the light in the room so that it does not hit the child's eyes directly and allowing the best view of the adult's face expression and lip-reading. The best placement is when the two speakers are located at the side away from the window so that daylight does not fall on anyone's face. The camera should be placed away from the source of light pointing straight at the child and parent so that their facial expressions, body language, gesture and signs can be easily and clearly seen.

Normally, the recording lasts between 5 and 15 min continuously but only a section of 5 min is transcribed. For children with severe disabilities (e.g. children with attention disorders or hyperactivity) recording 10–15 min can be too demanding. In this case, 20 communication turns are sufficient for an accurate evaluation of the modality of the communication.

Generally, two identical situations are suggested (using clinic-owned materials): reading a story with visual support (illustrated book) or playing with constructive toys (e.g. puzzle, cubes). For children with comorbidities, these situations are difficult to achieve, therefore we suggest the use of familiar, well-known toys or books (brought from home): bright toys for children with visual impairment and simple illustrated books which match their cognitive abilities.

Measures and transcript

The transcript analyses 20 communicative turns by the two speakers; linguistic, metalinguistic and paralinguistic parameters are transcribed.

The maternal communicative style as well as the complexity and the adequacy of the linguistic input given to the child by the parents are two very important parameters that need to be recorded.

With regard to the standard method, the child's progress is monitored in four areas: turn-taking, autonomy, eye contact and awareness. Autonomy and awareness especially show more substantial changes compared to the video analysis in children without complex needs.

Normally, turn-taking has two features: non-vocal turn-taking (silent gesture or sign) and vocal turn-taking. In children with severe psychomotor delay or cerebral palsy the turn-taking can occur through non-specific gesture: a gaze, a smile, a vocalization, a lament or a little and non-specific movement of a body part (sometimes a light muscle contraction). Autonomy occurs when the turns of the child contain elements (gesture or vocalizations) that could not be predicted by the adult during preceding turns or when the child takes an active part in the interaction providing new information. The autonomy of children with severe disabilities can be evaluated not only from gesture or voice but also from non-verbal behaviours. The evaluation of this category is the most difficult one among the four and it requires the support of the parents to interpret the child's behaviour and to understand the child's communicative intentions.

The third area concerns the eye contact with either the adult or the object of discourse. This criterion is not applicable to children with visual impairment or motor palsy of head and neck muscles. When it is possible to evaluate this category, the most important parameter to take is the adequacy of the use of eye contact because, together with all other communication channels, it is essential for the child in order to become a good communicator.

The role of the visual channel is more important during the first stage of communication in deaf children than in hearing children. In hearing children, approximately at three years of age, eye contact decreases. In addition, deaf children without associated disabilities show, 12 months after the implantation, a decrease in eye contact thanks to progressive development of the auditory process and to the nature of the

communicative situation.[21] In other words, these children develop a more appropriate and efficient communication. Instead, in deaf children with complex needs, eye contact persists for a longer period. Measuring eye contact in these children must take into consideration their slower reaction time and their difficulty in spatial orientation.

Auditory awareness takes place when the child's replies correspond to the last few words of the adult's preceding turn or when he vocalizes without any eye contact with the speaker. This means that the child is using the highest level of their hearing to hold a complex communication. In this category, the most important parameter to take is the 'Non-Looking Verbal Turn' (NLVT) in order to evaluate auditory rehabilitation. NLVT is an essential parameter because it reveals when the level of the child's hearing is suitable for holding a complex communication. If the child takes the turn in an effective and functional way with no eye contact, then it means an optimal auditory reinstatement has been achieved (with cochlear implant or hearing aids).

When evaluating the NLVT in children with comorbidities it is important to observe their smallest reaction and behaviour in response to the parent's turn. In particular, the observation has to be focused on the modification of eye movement, gestures, muscular tone, mood, body movement and vocalization. For instance, if a child smiles when the parent calls, it means that there is a good NLVT; on the other hand, no response means the absence of NLVT.

In summary, the improvement in the children with complex needs who have been fitted with hearing aids or cochlear implants is highlighted by the presence of non-specific responses, in particular the awareness, the shared attention, the non-specific phonemic production, the promptness and the time of reaction and the turn-taking. In order to evaluate these improvements, some questionnaires or tests are commonly used, but only a flexible and easy tool like video analysis allows the exact identification of these characteristics.

Table 1 summarizes changes in the four areas of the video analysis in deaf children with associated disabilities.

The transcript of the video analysis of children with comorbidities needs to be assessed in a particular way.

The total number of turns are counted for both vocal turn-taking and non-vocal turn-taking (gesture, sign or no response), the same as the standard method. The turns taken as gesture or vocalization are counted and expressed in percentage terms.

The measure of autonomy is different as this feature, in deaf children with complex needs, occurs in a non-conventional mode and often these children have no vocal autonomy.

Eye contact, when it is possible (i.e. where there is no visual impairment), is measured in a similar manner to the standard method. In the transcript, the adult's words are reported by using broken lines to underline the word when the child is looking at the adult. Solid lines are used to underline the reported adult's words when the child is not looking at the adult.

Measuring the NLVT needs changes because children with complex needs rarely use vocalizations or words with communicative intent and the evaluation of this ability is complicated even for a highly-skilled therapist.

Family communicative style

In the video analysis standard transcript, the family environment (especially maternal communicative style) is not considered. In the literature, there is common agreement on the role of the family environment in influencing outcomes for deaf children with cochlear implants (or hearing aids).[22,23]

Parents are the main linguistic source during the first years of life and, according to Longobardi et al., the

Table 1. Changes in video analysis in children with complex needs (*gaze, smile, vocalize, lament, little and non-specific movement of a body part).

	Behaviours	
Areas	Children without complex needs	Children with complex needs
Turn-taking	Vocal Non-vocal (silent gesture or sign)	Vocal Non-vocal Non-verbal behaviours*
Autonomy	Vocal Gesture	Vocal Gesture Non-verbal behaviours*
Awarness (NLVT)	Vocal	Vocal Non-verbal behaviours*
Eye contact	Adequacy of the eye-contact	Sometimes not applicable (visual impairment)

Table 2. Video analysis: measure systems comparison ([1]for children without complex needs; [2]for children with complex needs)

Areas	Measure systems comparison (standard[1] vs modified[2])
Turn taking	No change
Autonomy	Change
Eye contact	No change
Awareness	Change

maternal communication style is the most important parameter for the evaluation of outcomes for deaf children.[22,24] Moreover, the communication style is critical for those parents who have to interact with children with hearing loss and complex needs as they have to handle non-conventional and compromised communication.

Five types of maternal communicative style can be used to evaluate the interaction between the parent and child: tutorial, educational, directive, conversational and underestimating.[24]

The conversational style can be adopted when a deaf child has mild disabilities (mild developmental delay or neurological deficits). In particular, the maternal reflective method is an oral approach to language teaching which was pioneered by Father Van Uden, an educational psychologist. This approach is based upon conversational interaction between the deaf child and a more mature language user.

For deaf children with more severe complex needs, only two communicative styles (tutorial and educational) are positively correlated with language development.[25] In a recent paper, Roberts and Kaiser explained the meaning of the tutorial-educational style. The parent 'increases interactions with his child', answers the child's questions, uses 'child-directed speech' (talking about the objects that interest him, using simplified speech), emphasizes important words in a sentence and expands on what the child has said.[26]

We suggest a specific parent training aimed at improving the tutorial-educational interaction to achieve good progress in the communication of these children.

The video analysis for the evaluation of deaf children with complex needs and cochlear implants or hearing aids, must contain an analysis of the maternal communicative style in order to show parents how they can facilitate the development of effective communication for their child.

Discussion

Children at the very first stages of development acquire essential skills for linguistic communication but various studies report important differences between hearing and deaf children.

From one to three years of age, children's communication increases and they develop an intention to communicate. This communication is similar in quantity, modality and dialogic characteristic both in hearing and deaf individuals.[27] Nevertheless, compared to children without hearing loss, deaf children use more non-linguistic methods (points, gestures, vocalization and facial expression) and their communication is less spontaneous, less responsive and they are able to maintain shorter attention on a topic than hearing children.[28,29]

Given that about 40% of children with hearing loss have one or more disability, the development of communication is more complicated because all the aspects of the communication can be altered; therefore, these children cannot be evaluated with standard tests.[1–4,30]

Even more complicated is the evaluation of communication in deaf children with complex needs who are fitted with cochlear implants.[5,10,12–15] Age of onset, degree of hearing loss and a correct use and mapping of the cochlear implant influences the communication of these children. Furthermore, the number, type and severity of the disabilities lead to different outcomes in deaf children with cochlear implants.

It is essential, for these complex children, to consider the relationship between them and their parents for the evaluation of the communicative approach of both. This will help parents to develop effective interactions which contribute to good communicative progress. The role of the parent in the rehabilitation of deaf child with complex needs is critical because when living together every day any interaction produces continuous rehabilitation.

Roberts and Kaiser, in a recent review, supported this thesis by asserting that children use everyday activities and conversations shared with the key people of their lives to learn how to communicate. Parents have many more opportunities to interact with their child in everyday meaningful situations than a therapist does. They know their child best and represent her/his first teacher.[26]

In particular, parental directive communication style influences negatively the score in linguistic tests, whereas tutorial and educational styles are positively correlated with language development.[25] Better receptive and expressive language and better auditory outcomes are also associated with a higher level of maternal education.[4,31]

Roberts and Kaiser also report how good progress can be after parents' participation in a parent

implemented training programme for children with language difficulties (language impairment, autistic spectrum disorder and developmental delay). These children demonstrated improved expressive skills, understanding, vocabulary, grammar and communication frequency.[26]

It can be deduced that family support plays a crucial role in improving the outcomes of deaf children with complex needs. The outcome for these children depends on multiple factors: age of onset, age at fitting, severity of hearing loss, correct use of cochlear implant (or hearing aids), number, type and severity of the associated disabilities, family involvement and parental communicative style.

Therefore, it is essential to use an evaluation tool able to analyse the complex performance of the children with associated disabilities where standard tests (tailored to normal-developed children) cannot be applied.

Very important also is the use of the caregiver report questionnaires, the same as the Parents' Evaluation of Aural/Oral Performance of Children (PEACH) that evaluates the benefit of children's amplification (hearing aids or cochlear implant) by a systematic use of parents' observations.[30]

The Deafness and Additional Disabilities Questionnaire (DADQ) is another tool for measuring changes in everyday activities of deaf children with complex needs and evaluates the children's skills in five areas: perceptual skills, preferred communication mode, communication behaviours, attention and memory and social interaction, control of the behaviour and self-government.[32]

The Tait video analysis, which represents a different approach, monitors and measures improvements in very young children with a cochlear implant or hearing aids through video recordings. This tool is much better than others as it is able to measure the parental communicative style, also making parents bring about improvements in the communication with their child. Therefore, we recommend video analysis for monitoring deaf children with complex needs regardless of chronological age. This is a good tool because it is economic, non-invasive, non-traumatic and applicable in a familiar environment (home, school or therapist's room). It is also suitable for comparing progress over time.

Once instructed, parents can make recordings by themselves and share with the doctor or speech and language therapist in order to evaluate the child's abilities, proper use of CI or hearing aids and adequacy of communication between parents and child.

The standard video analysis does not consider the family environment. Various studies report that the family (in particular, tutorial and educational maternal communicative style) influences the outcome of the children with hearing loss and mainly the outcomes of deaf children with associated disabilities.[22,25]

For these reasons, we believe that is very important to include in the video analysis the evaluation of the maternal communicative style for helping families in developing an efficient communication with their deaf children.

Conclusion

The Tait Video Analysis can be a tool of evaluation from which useful information can be drawn when dealing with deaf children with associated disabilities even if it cannot be applied under its standard form. Together with questionnaires and direct observation, it provides a way to measure patients' improvements in the communicative exchanges and is a good tool for parents' counselling.

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The authors have no conflicts of interest to disclose.

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