PRINCIPLES OF CREATION OF COMPLEX PHYSICAL REHABILITATION PROGRAM FOR CHILDREN AFTER COCHLEAR IMPLANTATION

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Abstract. *Purpose:* to elucidate main principles of complex physical rehabilitation program for senior pre-school age children after cochlear implantation. *Material:* 40 hard hearing children of senior pre-school (main group) were tested. Main group №1 consisted of hard hearing children (10 boys and 11 girls), who did not underwent cochlear implantation and learned by program of pre-school educational establishment for hard-hearing children. Main group №2 consisted of 19 children after cochlear implantation, registered at oral-aural specialists (10 boys and 9 girls). For them the author's program of physical rehabilitation was worked out. Comparison group consisted of 40 children with normal hearing (18 boys and 22 girls). Effectiveness of the worked out program was assessed by parameters of physical and psycho-motor condition, by children's physical qualities. *Results:* the offered program of children's physical rehabilitation was developed on the base of assessment of physical and psycho-motor condition, physical fitness. The program is of complex character and includes the following elements: domestic habilitation, kinetisotherapy methodic (morning hygienic exercises, Yoga for children, health related training complex, fit-ball training, breathing and articulation exercises), massage (general, speech therapy massage), hardening. *Conclusions:* Complex character of the worked out program implies diverse influence on different disorders in children's organisms. All these are realized against the background of main etiological factor of these changes (deafness) removal. Such approach results in improvement of children's condition, their quicker socialization and possibility to study in comprehensive school in due time.

Key words: children, cochlear implantation, physical rehabilitation, psycho-motor, fitness.

Introduction

Already conducted researches of hearing in different countries showed that approximately 4-6% of all world population have hearing disorders. All these complicate social communication. With it, about 2% of population has two-side significantly expressed hard hearing [14, 16]. As per statistical data in Ukraine there are nearly 100 thousand deaf people, from them 11 thousand children with hearing defects of different etiology [8]. In this connection there ap-pears a problem to ensure full development and social adaptation of children with restricted hearing.

Recent years, in Ukraine cochlear implantation (CI) has been acquiring still more popularity as highly effective method of deaf children's rehabilitation. Such approach permits to renew hearing and speech and to live full life. With it, among implanted there increases quantity of early age children. These children are one of the most promising categories of candidates to CI. It is connected with importance of initial years of child's life for potential development of oral-aural and oral-motor rain centers [11, 12, 15]. Pre-school age is the most responsible stage of organism's development and on of the most important in formation of personality. In this period basis of health, full physical development are embedded; stabilization of biological pre-conditions for personal psycho-motor development is realized [11, 19].

CI is an efficient mean of deaf persons' rehabilitation. But for full and harmonious child's development it will be useful only in combination with further insistent rehabilitation: correction of exclusively hearing functions, disorders of psychic and physical conditions. The purpose of postoperative oral-aural rehabilitation is teaching to perceive hearing irritations (verbal and non-verbal); teaching to understand them and use new hearing senses for training of oral speech [5, 9, 13, 18].

After CI children become absolutely new contingent of physical rehabilitation. The existing scientific approach-es concern correction of children's with permanent deafness state. The problem of rehabilitation of children after CI is regarded exclusively from pedagogic point of view, though their physical condition is abnormal, because it was formed in conditions of hearing deprivation. At the same time, children after CI are characterized by high rehabilitation poten-tial. Plasticity of brain and potential of normal physical growth permit them (with appropriate rehabilitation) to quickly catch up their healthy peers [20, 21].

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Purpose, tasks of the work, material and methods

The purpose of the research is to elucidate main principles of complex physical rehabilitation program for senior pre-school age children after cochlear implantation.

Material and methods of the research: theoretical analysis and generalization of scientific-methodic literature data as well as own experience as the basis of authors' physical rehabilitation program for senior pre-school age children after CI creation.

We tested 40 hard hearing children of senior pre-school age (main group). Main group №1 (MG1) consisted of hard hearing children (10 boys and 11 girls), who did not underwent cochlear implantation and learned by program of pre-school educational establishment for hard-hearing children. Main group №2 (MG2) consisted of 19 children after cochlear implantation. They were registered in oral-aural specialist of Center of medical-social rehabilitation for children with nervous system's organic lesions of Ivano-Frankivsk regional children's clinical hospital (10 boys and 9 girls) of age 5.3±0.2 years. For them the author's program of physical rehabilitation was worked out. Control group (CG) consisted of 40 children of 5.1±0.3 years' age with normal hearing (18 boys and 22 girls). Effectiveness of the worked out program was assessed by parameters of physical and psycho-motor condition, by children's physical qualities. Effectiveness of the worked out program was assessed by parameters of physical and psycho-motor condition, by children's physical qualities.

Results of the research and discussion

When creating the program we considered that development of all psychic functioning components of children is closely interconnected. In such case formation of hearing and speech depend on psycho-physiological status, especially on level of intellect and cognitive processes. That is why compulsory element of children's after CI rehabilitation is development of non-verbal functions, which are not connected with speaking. Non-verbal measures were based on data about normal formation of this age children's psycho-motor skills and corresponded to program of common pre-school educational establishment. It included development of the following: motor functioning, perception of surrounding world, attention, thinking, emotional-will sphere [1].

Specific feature of early rehabilitation of children after CI is that it has intensive, complex character and shall be realized by a number of specialists – rehabilitation specialist, speech pathologist, speech therapist and psychologist. Effect of specialists' functioning is summed up at the account of diverse actions, oriented on achievement of total result. The purpose of such approach is maximally efficient training to perception of speech, correction of delays in physical and psychic development and preparation for studying in comprehensive school [5, 11, 13].

Complex program of physical rehabilitation of children after CI was implemented during one year in three stages: preparatory, main and supporting (see fig.1). Control over functional systems' state was fulfilled before beginning of the program's implementation and after every stage. The purpose of this control was assessment of load's adequacy and the offered means' effectiveness.

Active cooperation with parents was an integral part of the worked out rehabilitation program. With it, we considered that pre-school age child quickly tires and the time of his (her) being in rehabilitation conditions is rather restricted. It should be noted that such child requires very intensive correction [9, 11]. Most part of day child spends with parents (as far as he (she) does not attend pre-school educational establishments); the parents are examples of behavior and are the main circle for child's communication. Child with hearing problems to large extent copies parents' behavior visually even, when he (she) starts hearing. That is why under supervision of rehabilitation specialist parents realized such components of rehabilitation program as early hygienic morning exercises, hardening, independent kinesiotherapy exercises, breathing articulation complex.

Disorder of oral-aural function is connected etio-patho-genetically with lagging in physical and psycho-motor development, detected in initial testing [3, 4]. For solution of these problems we used the following means of physical rehabilitation.

Recommendations on domestic habilitation of children after CI

- Ensure ensure eating full of calories and vitamines-micro-elements, which would correspond to increased child's requirements, resulted from intesification of physical activity;
- Activate fine motor abilities (bending and unbending of fingers in fist, tapping musical rhythm on table with fingers; rolling of ridge objects wih hands; making traceries with small objects, seeds, mosaic; play with small toys, constructor, puzzles and etc);

Stage	Month	Training mode	Tasks	Means							
Preparatory	1 2 3	Moderate	*Initial control* Organism's adaptation to increasing physical loads Mastering of the offered methodic of physical qualities' and physical condition correction Correction of psycho-motor development Setting of initial oral-aural contact with rehabilitation specialist and parents	Every day independent trainings with parents	Kinesiotherapy	Kinesiotherapy (Yoga for children) – twice a week – in rehabilitation center Articulation exercises, everyday with parents Breathing play complex – 3 times a week, with parents	Recommendations on domestic habilitation	Massage	General – 10 sessions Speech therapeutic – 20 sessions	Hardening	Air
Main	4 5 6 7 8 9	Training-moderate	*Intermediate control* Development of oral-aural function Improvement of cardio-vascular and respiratory systems' functions Correction of psycho-motor development Further development of physical qualities Improvement of physical condition and posture indicators General strengthening of children's organism			Kinesiotherapy– 3 times a week – in rehabilitation center Articulation exercises, everyday with parents Breathing play complex – 3 times a week, with parents			General – 10 sessions Speech therapeutic – 15 sessions		Air, Sun and water
supporting	10 11 12	Training	*Intermediate control* Fixing of the received results Further improvement and stabilization of internal organs' functions Further development of physical activity Improvement of physical endurance Further development of physical qualities Preparation for studying in comprehensive school *Final control*			Kinesiotherapy–twice a week (fit-ball) – in rehabilitation center Articulation exercises, everyday with parents Breathing play complex – 3 times a week, with parents			General – 10 sessions Speech therapeutic – 10 sessions		

Fig.1. Diagram of complex rehabilitation program for senior pre-school age children after CI

- Train new movements in calm atmosphere, repeat them together wih child;
- Constantly comment actions, fulfilled by child, with clear and simple words;
- Teach child to fulfill action immediately by signal;
- Attract child's attention to surrounding sounds and speech; train to correlate ound and source of sound, explain the meaning of sound;
- Suport different forms of music's perception: listening to music, singing, playing musical instruments, dances under rhythmical music;
- Encourage domestic communication with peers, having normal hearing;
- Create habitual situations and actions of repeated character;
- Make pauses between phrases, giving chance for child to answer;
- Conduct trainings in morning time, when child is not tired.

Program of kinesiotherapy

The purpose of kinesiotherapy was: correction of lagging in physical development, acceleration of oral-aural rehabilitation, improvement of general condition through normalization and increasing of internal organs' functional reserve, overcoming of general immobility. Kinesiotherapy program was implemented in the form of trainings in rehabilitation center and trainings with parents. Their frequency was conditioned by density of child's schedule (meaning other kinds of rehabilitation trainings and considering inadmissibility of child's physical and emotional overloading, especially in period just after CI). That is why frequency of kinesiotherapeutic trainings in preparatory period was twice a week (20 minutes every training); in general stage – 3 times a week (25 minutes – duration) and in final stage – twice a week with 30 minutes' duration of every training. With parents breathing and articulation exercises, morning exercises were practiced every day.

In early period after implantation child has not normal hearing and reaction to sound and its understanding [5, 21]. That is why in moderate mode trainings were conducted as clearly as possible at slow rate. The purpose was to give opportunity for child to repeat. As far as children are usually not interested in the trainings it is necessary to use play method as often as possible.

In the process of working out of physical rehabilitation program for children after CI we observed: requirements of regulation, adequacy and strict dosing of physical loads; their systemic character; gradual widening of means, complexly influencing on internal organs and skeletal-muscular apparatus; selection of exercises in compliance with child's psycho-motor condition [1, 10].

Kinesiotherapy trainings in rehabilitation center both in preparatory and main periods were conducted individually. In final stage trainings were practiced with small groups and constant current control for monitoring of tolerability and adequacy of physical load. Kinesiotherapeutic trainings were divided in main, preparatory and final parts [6, 10].

Morning hygienic exercises (MHE)

MHE were practiced to make easier transition from sleep to active functioning. It was fulfilled everyday, in the morning, before breakfast, approximately at one and the same time in well ventilated room. After MHE hardening procedures were practiced. In preparatory period MHE duration was 10 minutes; in main and final periods – 15 minutes. MHE was practiced in the form of game. Every exercise was explained to child, for it to be clear and acceptable. For this purpose parents were recommended to learn all exercises previously.

Yoga for children

In the next rehabilitation period, kinesiotherapy trainings were conducted with application of Yoga for children exercises (baby yoga) – a kind of Kha-Tha yoga. Such session implies practicing of only asanas, which are technically acceptable for children [7].

We considered low level of CI children's physical fitness and therapeutic effectiveness of asanas. Such trainings were conducted for cultivation of children's habit for regular loads during day as well as for development of physical qualities (flexibility, endurance and coordination), organism's adaptation for increasing physical load.

The trainings were conducted in playing form. Asanas were named by known for child words, mainly names of grass or other plants: for example "posture of tree" or "posture of dog". It motivated children for recalling and repetition of images; improved their psycho-emotional state. Musical accompaniment was selected in compliance with

name of posture, i.e. with sound made by animal (for example, dog barking, cat meowing and etc). It made easier perception and remembering of new words and sound concepts.

Health related training complex

After mastering of simple movements by CI children and adjustment of oral-aural contact with rehabilitation specialist, kinesiotherapeutic (health related training) complex was started. The complex was oriented on correction of main health disorders.

The trainings included exercises for balance, psychic processes and hearing function activation. The trainings were fulfilled with rhythmic music accompaniment [10]. Means for development of speed-power qualities were: different kinds of run, jumps, throws, exercises with ball. Playing method included mobile games, repeated tasks, and in-game compositions.

Correction of balance was conducted with exercises on reduced support area. Well mastered and safe exercises (walking, stances) first were fulfilled with open eyes, then – with closed. All exercises for balance correction and training were fulfilled with support.

Complex of exercises for vestibular disorders and resistance to vestibular irritators required preliminary training of technique. Exercises were fulfilled in three planes, mainly in motion. We considered that exercises with bent head in frontal plane influence on frontal channels of vestibular apparatus. Irritation of horizontal semi-circular channels was caused by torso rotation, by 180° (360°) turns, in jump from the spot, in walking and run. Eolith apparatus is influenced by beginning and end of linear motion, acceleration and slowing of movements. For increasing of influence on vestibular system previously mastered exercises were fulfilled with closed eyes. It activated other compensatory mechanisms of perception. Besides, throws of different diameters and weight balls for accuracy were fulfilled. This exercise is a strong irritator of vestibular apparatus. In this exercise children have to bend head back, tense eyesight, coordinate movements and keep balance.

Aerobic with fit-ball

Up to final rehabilitation stage children already acquired skills in oral-aural communication. That is why kinesiotherapeutic trainings with fit-ball were conducted with small groups. It facilitated children's communication, creation of game atmosphere; it permitted to carry out exercises in pairs. Fit-ball trainings had the purpose:

- Strengthening and development of arms', shoulder girdle muscles; training of abdomen, back, legs' and foot arch muscles;
- Improvement of joints' flexibility and mobility;
- Training of balance and vestibular apparatus functions;
- Formation of correct carriage and prophylaxis of flat feet;
- Training of dexterity and motor coordination;
- Training of musicality and perception of rhythm;
- Training of aerobic endurance.

The trainings included different kinds of walk, jumps at the spot and in motion; jumps with fit-ball in hands and between legs, sitting on it. Children fulfilled general exercises, sitting or lying on ball, using fir-ball as object.

Articulation exercises

The purpose of articulation-breathing gymnastic for CI children was: training of full movements and definite positions of articulation apparatus's organs, which are required for correct pronunciation of sounds and smooth breathing, as well as for expansion of respiratory system's functional reserves [2].

Articulation exercises were recommended to be fulfilled every day in playing form with parents after analyzing of every exercise with rehabilitation specialist. Duration of exercises was 5-7 minutes; 3-5 exercises in one session with quantity of exercises' repetition 5-7 times. Static exercises were fulfilled during 10-15 sec.

Articulation gymnastic included exercises for lips and development of their mobility as well as exercises for cheeks, static and dynamic exercises for tongue, for lower jaw's mobility, throat muscles and soft palate.

Breathing exercises

Demand in breathing exercises was conditioned by low functional indicators of CI children's respiratory system. Besides, it was necessary to control these indicators in the process of oral speech development. It was also necessary to train deeper inhale in CI children and longer, smooth exhale; to correctly regulate breathing. Breathing games with usage of fine objects, included in program, train fine motor skills and creative thinking (for example in

the process of making required for the objects – snowflakes, butterflies, paper boats and so on). Besides, we familiarized children with new figural concepts, required for better mastering of oral speech.

Massage

General massage

Rehabilitation program included restorative massage for organism's general strengthening. All techniques of classic massage were applied. Softer and gentler influences were preferred: different kinds of stroking, careful rubbing with finger tips and soft kneading. Light strikes were fulfilled by fingers and palms. Criterion of intensity in massage techniques was full absence of pain and unpleasant feelings, which could cause reflex muscular tension and child's fear of rehabilitation procedures. Intensity and depth of massage techniques were increased gradually. With it we avoided expressed child's fatigue after massage session [6].

We practiced ten sessions of general massage in every rehabilitation period: at the beginning of preparatory and final and in the middle of main period. This massage did not intersect with sessions of speech therapeutic massage (in total three courses). Duration of session in preparatory period was 20 minutes; in main – 25 minutes; in final – 30 minutes. General massage was fulfilled 2 – 3 times a week, depending on rehabilitation period.

In massage passive movements in all joints are widely used. Special attention was paid to massage of fingers' and wrist joints. Its purpose was to make fine motor abilities' training easier. In feet massage we additionally toned muscles of arch. Besides we accented on back, chest and neck area muscles. Its purpose was improvement of additional and articulation apparatuses' trophies, expansion of respiratory organs' functional reserves, strengthening of back muscles for improvement of carriage.

Massage session was finished with general massage of all body with multi-needle applicator of Liapko ("needle shower") Applicator massage was practiced with child in standing position in the following sequence: legs, arms, front and back of torso. Duration of such massage was 2-3 minutes.

Articulation massage

Articulation (speech therapeutic) massage was conducted for normalization of general, facial and articulation muscular tonus; for reduction of articulation apparatus muscles' dystonia; stimulation of pro-prioceptive Артикуляційний (логопедичний) масаж проводили з метою нормалізації м'язового тонусу загальної, мімічної і senses; increasing of amplitude and scope of articulation movements; activation of those muscles of periphery speech apparatus, which had insufficient contracting functioning; for improvement of spontaneous coordinated movements of articulation organs [2].

In worked out articulation program we used strengthening manual speech therapeutic massage. Such massage is based on classic technique. Sessions were conducted by the following schema: in preparatory period – thrice a week – 20 sessions; in main period – two cycles (15 sessions in each) with pause of 3 months, twice a week; in final period – 10 sessions – twice a week. Initial duration of procedure was 5-7 minutes. Then it gradually increased to 20-25 minutes.

The massage was carried out in the following order: facial muscles, lips' muscles, tongue's muscles, neck and shoulder girdle's muscles. Speech therapeutic massage finished by general soft massage of mentioned areas, front of neck and adjoining area, front and back of chest by Liapko's applicator – roller during 1-2 minutes. Its purpose was increasing of speech therapeutic massage effect.

Hardening

Children's hardening had purpose to achieve general strengthening of organism, prevention from catarrhal diseases and improvement of immune system [1, 6]. In the worked out by us rehabilitation program we used hardening by low temperatures. It is the simplest method for domestic conditions. It was realized by parents under supervision of rehabilitation specialist by the following means:

- General: correct day regimen of day, rational eating, practicing of physical culture;
- Special: hardening by air (air baths), Sun (Sun baths) and water (washing, contrast baths for lower limbs, rubbing).

Effectiveness of the created rehabilitation program was proved by confident ($p<0.05$) results in respect to initial indicators of CI children, showing improvement of anthropometric indicators (body mass, chest, arm, hip circumference), physical qualities (strength, dexterity, endurance, flexibility) [3, 4].

The data, received in the process of scientific research, prove acuteness of the problem of correction of deaf children's health (Forostian O., 2001; Vypasniak I.P., 2004; Liakhova I.M., 2005; Baykina N.G., Kret Ya.V.,*2007; Ivakhnenko* A.A., 2011) and rehabilitation of special contingent of hard hearing children after CI (I.V. Koroliova, 2005; O.V. Zontova, 2007; B.S. Moroz, 2013).

For the first time the fulfilled research substantiated demand in creation of correction-pedagogic and physical rehabilitation program for CI children. The presented in the program means are proved and acceptable for application in any center, dealing with problems of the mentioned contingent. Specific feature of this rehabilitation program is complex approach to recreation of physical and audio status of a child: methodic of deaf child's recreation as a member of society with normal hearing and physical condition.

Conclusions

The presented physical rehabilitation program for senior pre-school age children after CI was worked out on the base of assessment of physical and psycho-motor condition and physical fitness. The program has complex character and includes the following elements: domestic habilitation, kinesiotherapy methodic (morning hygienic gymnastic, Yoga for children, health related training complex, fit-ball trainings, breathing and articulation exercises), massage (general and speech therapeutic), hardening.

Complex character of the worked out program implies diverse influence on different disorders in children's organism. All these are realized against the background of removal of these changes (deafness) main etiologic factor. Such approach results in improvement of children's condition, their better socialization and possibility to study in comprehensive school.

The prospects of further researches in this direction imply detail study of the worked out program's influence on functioning of senior pre-school age children's organism after cochlear implantation.

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Conflict of interests

The author declares that there is no conflict of interests.

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