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Article

Optimization of Treatment For Sensorineural Hearing Loss of Infectious Origin

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Abstract: The aim of this work was to optimize treatment methods for sensorineural hearing loss of infectious genesis. The object of the study was 115 children in the age category from 1 year to 7 years with SNHL in association with toxoplasmosis and CMV infection, who were included in the main group and in the comparative group of 30 children diagnosed with SNHL without toxoplasmosis and CMV infection. The main group received antiviral therapy, and the comparison group received traditional therapy. Both study groups underwent **whispered and spoken speech perception tests**. **Hearing Improvement Based on Speech Perception Tests. Whispered speech perception test (up to 3 meters):** Before treatment, **6 children (5.2%)** in the main group were diagnosed with **Grade I SNHL**. **Spoken speech perception test (up to 6 meters):** Before treatment, **7 children (6.1%)** in the main group were diagnosed with **SNHL**. To achieve the set goals, the authors also conducted ABR after treatment in the study groups. Thus, strong correlation relationships were revealed between specific antibodies of pathogens, cytokine status, and inflammatory proteins.

Keywords: Sensorineural hearing loss, cytomegalovirus, toxoplasmosis, pediatric audiology, antiviral therapy, immunocorrection, auditory brainstem response, cytokine correlation.

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1. Introduction

Hearing impairments (HI) are the most common sensory pathology in children. The problem of timely detection of hearing impairments in children has not only medical but also social significance and holds a special place in the structure of otorhinolaryngological morbidity. Among the significant etiological factors of sensorineural hearing loss (SNHL) in childhood, infectious diseases account for 25%.

In 5.9% of cases, SNHL was caused by intrauterine infections such as cytomegalovirus (CMV), herpes, toxoplasmosis, and influenza. According to the World Health Organization (WHO), 17% of congenital hearing loss cases are due to perinatal pathology.

British researchers estimate that congenital hearing loss occurs in 1.79 per 1,000 newborns. By the age of five, the prevalence of persistent hearing loss increases to 3.65 per 1,000 children, with mild and unilateral forms occurring at a rate of 2.13 per 1,000 children of the corresponding age.

The prognosis for a child with sensorineural hearing loss (SNHL) or deafness directly depends on the timeliness of diagnosis and the adequacy of the chosen treatment strategy. Early intervention significantly increases the chances of complete recovery in many

children and helps prevent disease progression in cases associated with intrauterine infections.

In such cases, treatment that includes medications and therapeutic procedures aimed at improving cochlear blood circulation, eliminating infectious toxins, and enhancing metabolic processes in hair and nerve cells has a positive impact on the auditory and speech motor centers of the brain. This improves the child's responsiveness to sounds and facilitates the development of spoken language.

Problem Relevance

The selection of an effective therapeutic strategy for newborns and young children with SNHL caused by toxoplasmosis and cytomegalovirus (CMV) infections remains a critical, complex, and largely unresolved issue. Despite extensive research on SNHL and its treatment methods, the number of children with hearing impairments continues to increase, highlighting the urgent need for further investigation into early diagnosis, treatment, and rehabilitation approaches.

To this day, the mechanisms of SNHL development associated with toxoplasmosis and CMV infections remain controversial, requiring deeper study.

Study Objective

This study aims to optimize treatment methods for sensorineural hearing loss of infectious origin (toxoplasmosis and CMV-related SNHL).

2. Materials and Methods

Between **2021 and 2023**, a total of **145 children with sensorineural hearing loss** were examined at the **Multidisciplinary Clinic of Samarkand State Medical University**. **Study Groups. Main group (I):** 115 children aged **1 to 7 years** diagnosed with **SNHL associated with toxoplasmosis and CMV infection**. **Comparison group (II):** 30 children diagnosed with SNHL **without toxoplasmosis or CMV infection**. **Treatment Approaches. Group I:** Received **comprehensive treatment**, including **traditional therapy**, additional medications, **antiviral therapy (flavonoid glycosides), and immunocorrective therapy** (sodium aminodihydrophthalazinedione according to protocol). **Group II:** Received only **traditional therapy**. Children underwent **follow-up examinations every six months over two years**. **Antiviral therapy** was administered every six months based on specific **antibody levels**. These medications also had **partial neuroprotective effects**, enhancing the **protective properties of nerve and sensory cells**. Since **early initiation of treatment is one of the most critical factors for successful recovery**, children were later discharged with **maintenance therapy** to support their progress.

3. Results

To objectively assess the effectiveness of our proposed **comprehensive treatment**, both study groups underwent **whispered and spoken speech perception tests**. **Hearing Improvement Based on Speech Perception Tests. Whispered speech perception test (up to 3 meters):** Before treatment, **6 children (5.2%)** in the main group were diagnosed with **Grade I SNHL**. **Spoken speech perception test (up to 6 meters):** Before treatment, **7 children (6.1%)** in the main group were diagnosed with **SNHL**. **Post-treatment results: 9 children (7.8%)** in the main group experienced **complete normalization of hearing**. **Whispered speech perception test (up to 0.5 meters): 18 children (15.7%)** in the main group were diagnosed with **Grade II SNHL**. **Spoken speech perception test (up to 3 meters): 25 children (21.7%)** in the main group had **Grade II SNHL**. **Post-treatment improvement: 5 children (4.34%)** experienced significant **hearing improvement**, reducing SNHL severity to **Grade I**.

Whispered speech perception test results for Grade III SNHL: 17 children (14.8%) in the main group were diagnosed with **Grade III SNHL**. **Spoken speech perception test (up to 0.5 meters): 23 children (20.0%)** were confirmed to have **Grade III SNHL**. **Post-treatment improvement: 13 children (11.3%)** improved from **Grade III to Grade II SNHL**. **Hearing outcomes for Grade IV SNHL:** No **significant hearing improvement** was observed in **children with Grade IV SNHL** following conservative treatment. **Auditory Brainstem Response (ABR) Testing After Treatment**

To further assess hearing function, **ABR testing** was conducted in both study groups. **Findings in the Main Group (I): SNHL diagnosed in the right ear: 38.31±1.12 children. SNHL diagnosed in the left ear: 47.31±1.12 children. SNHL Grade I in the right ear: 28.0±2.83 children (p<0.001) SNHL Grade I in the left ear: 37.5±3.54 children (p<0.001) SNHL Grade I-II: Right ear: 48.81±0.07 children. Left ear: 58.3±0.96 children. Comparison group (right ear): 39.0 ±1.12 children (p<0.001). Comparison group (left ear): 50.0±2.50 children (p<0.01) SNHL Grade II: Main group (right ear): 56.52±0.75 children. Main group (left ear): 62.61±0.63 children (p<0.001) Comparison group (right ear): 46.25±2.02 children. Comparison group (left ear): 51.00±2.26 children (p<0.001) SNHL Grade II-III: Right ear (main group): 62.63±0.82 children. Right ear (comparison group): 52.50±1.87 children (p<0.001) Left ear (main group): 65.53±0.54 children. Left ear (comparison group): 60.83±0.91 children (p<0.001) SNHL Grade III: Right ear (main group): 65.45±0.32 children. Right ear (comparison group): 61.25±1.44 children (p<0.01) Left ear (main group): 72.91±0.54 children. Left ear (comparison group): 68.75±1.44 children (p<0.01) SNHL Grade III-IV (significant improvements): Right ear: 76.57±1.00 children. Left ear: 96.29±0.70 children (p<0.05) SNHL Grade IV (significant improvements in the main group): Right ear: 94.00±1.41 children (p<0.001) Left ear: 96.00±1.41 children (p<0.01)**

The **main group, which received comprehensive therapy, showed significantly greater improvements** in hearing compared to the comparison group, which only received traditional treatment. **Children in the comparison group showed no significant hearing improvement** following standard treatment, as **ABR results remained unchanged**. **In contrast, the main group experienced a substantial normalization of hearing**: **Right ear: 19.13±1.04 cases (p<0.001) Left ear: 23.50±0.70 cases (p<0.001)**

Degree of Hearing Loss	I ст		I-II ст		II ст		II-III ст		III ст		III-IV ст		IV ст		Норма	
	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
Group I (Main Group, n = 115)	38,31±1,12	47,31±1,12	48,81±0,70	58,33±0,96	56,52±0,75	62,61±0,63	62,63±0,82	65,53±0,54	65,45±0,32	72,91±0,43	76,57±1,00	96,29±0,70	94,00 ±1,41	96,00±1,41	19,13***±1, 04	23,50***±0, 70
Group II (Comparison Group, n = 30)	28.00***±2.83	37.50***±3.54	39.00***±1.12	50.00**±2.50	46.25***±2.02	51.00***±2.26	52.50***±1.87	60.83***±0.91	61.25**±1.44	68.75**±1.44	67.50*±3.54	80.00*±7.07	80.71***±2.48	86.43**±2.56	-	-

These clinical findings confirm that **comprehensive therapy is significantly more effective in improving hearing function in children with SNHL associated with toxoplasmosis and CMV infection**. (Table 1).

Table 1. Correlation of ABR Test Results After Treatment in Children from the Main and Comparison Groups

Note: R1, R2, R3 – Statistical significance of differences after treatment between the main and comparison groups: *p<0.05; **p<0.1; ***p<0.001

To determine the direct or indirect influence of specific IgM and IgG antibodies to Toxoplasma and CMV infection on the levels of cytokines IL-4, IL-18, LF, and C-reactive protein (total and high-sensitivity) in the blood, a correlation analysis was conducted between the studied parameters before and after treatment (Table 2).

Table 2. Correlation Analysis Between Specific Antibodies and Immune Status Before Treatment

	IgM Toxoplasmosis	IgM CMV	IgG Toxoplasmosis	IgG CMV
IL-18	0,98	0,98	0,98	0,98
IL-4	0,97	0,97	0,97	0,97
LF	0,93	0,93	0,93	0,93
CRP (Total)	0,71	0,71	0,71	0,80
CRP (High-Sensitivity)	0,69	0,69	0,69	0,69

Note:

Significant positive correlations

Strong positive correlations

Weak positive correlations

Based on the correlation analysis before treatment, 20 significant correlations were identified: among them, 12 were strongly positive, 4 were significantly positive, and 4 were weak.

After treatment, the correlation analysis revealed 20 significant correlations: among them, 8 were fully positive, 9 were strongly positive, and 3 were moderately significant (Table 3).

Table 3. Correlation Analysis Between Specific Antibodies and Immune Status After Treatment

	IgM Toxoplasmosis	IgM CMV	IgG Toxoplasmosis	IgG CMV
IL-18	0,97	1,0	0,97	0,97
IL-4	0,98	1,0	1,0	1,0
LF	0,97	1,0	1,0	1,0
CRP (Total)	0,9	0,9	0,8	0,8
CRP (High-Sensitivity)	0,8	1,0	0,9	0,9

Note:

Moderately significant positive correlation relationships.

Moderately positive correlation relationships.

Complete functional correlation relationship.

4. Discussion

It should be noted that after treatment, the correlation relationships of the above-mentioned parameters were strongly positive, indicating the effectiveness of our proposed comprehensive treatment.

In addition, among the examined children, 25 (21.7%) from the main group with SNHL associated with toxoplasmosis and CMV infection of grade IV and 8 (26.7%) from the comparative group with SNHL underwent hearing aid fitting in addition to the above-mentioned treatment. Of these, 6 (5.2%) children from the main group with SNHL associated with toxoplasmosis and CMV infection underwent cochlear implantation (CI) based on medical indications. Among the 8 (26.7%) children from the comparative group diagnosed with SNHL of grade IV, 3 (37.5%) underwent CI, while 5 (62.5%) were included in the state program for cochlear implantation.

Thus, strong correlations were identified between specific pathogen antibodies, cytokine status, and inflammatory proteins. The obtained data can be used as diagnostic and therapeutic criteria for SNHL associated with toxoplasmosis and CMV infection.

Changes in immunological parameters suggest the inclusion of antiviral, antioxidant, and immunomodulatory drugs, the use of which improves clinical signs and laboratory indicators.

Modern hearing aids and cochlear implants, combined with early hearing rehabilitation, significantly enhance the role of parents and close relatives in the child's speech development, educational opportunities, and social integration.

5. Conclusion

Fundamental Finding: The study demonstrated that comprehensive treatment, integrating traditional, antiviral, and immunocorrective therapies, significantly improved hearing outcomes in children with sensorineural hearing loss (SNHL) of infectious origin, particularly those related to toxoplasmosis and cytomegalovirus (CMV) infections. **Implication:** These findings highlight the critical importance of early diagnosis and targeted multimodal therapy in preventing long-term auditory and developmental deficits, and support the use of immunological markers as both diagnostic tools and indicators of therapeutic efficacy. **Limitation:** However, the study is limited by its non-randomized design and reliance on clinical outcomes without incorporating quality-of-life measures or long-term developmental tracking. **Future Research:** Future studies should explore randomized controlled trials with larger cohorts, evaluate the long-term cognitive and social impacts of early intervention, and investigate the molecular mechanisms underlying immune response modulation in SNHL recovery.

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