

Leukocyte Shift Index in Purulent-Inflammatory Pathology of the Middle Ear in Children in the Age Aspect

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Abstract

The aim of the study was a comparative analysis of the blood value of the leukocyte shift index (LSI) in acute suppurative otitis media (ASOM) and chronic suppurative otitis media (CSOM), depending on the age of children.

Methods and Results: This study included 100 children (62 boys and 38 girls) aged 1-16 years who were diagnosed with ASOM and CSOM. The mean age of all patients was 7.59 ± 0.50 years. Group 1 included 50 patients (30 boys and 20 girls) with ASOM. Group 2 included 50 patients (20 boys and 30 girls) with CSOM. As a marker for determining the activity of the inflammatory process, we chose LSI, calculated taking into account the parameters of the general blood test. LSI levels in the patients of Group 1 and Group 2 were 2.08 ± 0.23 and 1.51 ± 0.16 , respectively ($P=0.0446$). The results obtained indicate that in children with mean age of 3.44 ± 0.31 years, the LSI level of 2.08 ± 0.23 can suggest the formation of ASOM. In children with mean age of 11.56 ± 0.46 years, the LSI level of 1.51 ± 0.16 can suggest the formation of CSOM.

Conclusion: The proposed method for predicting CSOM in children has enough grounds for clinical application in practical health care. (International Journal of Biomedicine. 2022;12(3):466-469.)

Keywords: chronic suppurative otitis media • leukocyte shift index • children

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Abbreviations

ASOM, acute suppurative otitis media; CSOM, chronic suppurative otitis media; LSI, leukocyte shift index; ME, middle ear.

Introduction

Chronic suppurative otitis media (CSOM), a complication of acute suppurative otitis media, develops in the absence of timely diagnosis and proper treatment and is one of the most common and dangerous diseases in pediatric practice. The number of patients reaches 14.4% of schoolchildren.⁽¹⁾ Clinical signs of the development of CSOM at preschool age include a history of acute otitis media up to 1 year of age, repeated

recurrences of otorrhea, previous adenotomy, and intractable suppuration from the ME. The development of otitis media with cholesteatoma in young children tends to have a more unfavorable course of the disease than in older children.^(2,3) For children older than 7 years, a fairly long history of ear disease is typical.⁽⁴⁾ Due to the characteristics of a growing child's body, the course of ME cholesteatoma in children also has a number of features, the main one being aggressiveness.^(5,6) Evidence of the aggressiveness of cholesteatoma in children is intensive growth and a high recurrence rate after surgery, compared with adult patients, as well as intracranial and purulent-septic complications.⁽⁷⁻⁹⁾ Predicting the development of CSOM and otogenic intracranial complications remains an urgent problem at the present stage in pediatric practice.^(10,11)

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The aim of the study was a comparative analysis of the blood value of the LSI in ASOM and CSOM, depending on the age of children.

Materials and Methods

This non-randomized prospective study included 100 patients (62 boys and 38 girls) aged 1-16 years who were diagnosed with ASOM and CSOM to determine the blood value of LSI. The mean age of all patients was 7.59 ± 0.50 years. All patients were treated in the department of pediatric otolaryngology at the Regional Clinical Hospital No.2 of Tyumen in the period from 2016 to 2020. Group 1 included 50 patients (30 boys and 20 girls) with ASOM. Group 2 included 50 patients (20 boys and 30 girls) with CSOM.

As a marker for determining the activity of the inflammatory process, we chose LSI, calculated taking into account the parameters of the general blood test. $LSI = (\text{eosinophils} + \text{basophils} + \text{myelocytes} + \text{metamyelocytes} + \text{stabs} + \text{segmented neutrophils}) / (\text{monocytes} + \text{lymphocytes})$.⁽¹²⁾ The LSI value of 1.96 ± 0.56 is considered normal.⁽¹³⁾ All children were admitted on an emergency basis with complaints of earache, difficult nasal breathing, headaches, unilateral or bilateral hearing loss, or discharge, hyperthermia, anxiety, and sleep disturbance.

All children were examined by an otorhinolaryngologist, pediatrician, and ophthalmologist, as well as by a neurologist, anesthesiologist, and neurosurgeon, according to the indications. Upon admission, patients underwent clinical and laboratory diagnostics, radiography, CT, and MRI, as well as CT or MRI with contrast according to the indications. Surgical treatment included myringotomy, antromastoidotomy, and radical surgery according to the indications. All received a course of antibiotic therapy, heparin therapy, and local therapy.

Statistical analysis was performed using the statistical software STATISTICA (v10.0, StatSoft, USA). The normality of distribution of continuous variables was tested by one-sample Kolmogorov-Smirnov test. Continuous variables were presented as mean \pm SEM. Means of 2 continuous normally distributed variables were compared by independent samples Student's t test. Mann-Whitney U test was used to compare means of 2 groups of variables not normally distributed. A value of $P < 0.05$ was considered significant.

The study was conducted in accordance with ethical principles of the WMA Declaration of Helsinki (1964, ed. 2013) and approved by the Tyumen State Medical University Ethics Committee. Written informed consent was obtained from the parent/guardian of each patient.

Results

LSI levels in the patients of Group 1 and Group 2 were 2.08 ± 0.23 and 1.51 ± 0.16 , respectively ($P = 0.0446$). The results obtained indicate that in children aged between 1 and 16 years, the LSI levels of 2.08 ± 0.23 can suggest the formation of ASOM, requiring surgical exudate evacuation (paracentesis) with the administration of systemic antibiotic therapy. The LSI levels of 1.51 ± 0.16 can suggest the formation of CSOM, which requires correction by surgical and conservative methods of

treatment. This index can be used to stratify patients at high risk of persistent hearing loss and intracranial complications.

Analysis of the LSI value within the studied groups, depending on age, did not show significant differences (Table 1) due to the small number of observations with minor fluctuations in this indicator: from 1.04 to 2.98 in Group 1 and from 0.75 to 1.74 in Group 2. A comparative analysis of the study groups by age categories showed significant differences (Table 1): from 0.86 to 13.04 years in Group 1 and from 5.0 to 14.46 years in Group 2. Table 2 presents the descriptive statistics according to age in the study groups. The average age of the patients in Group 1 and Group 2 was 3.44 ± 0.31 years and 11.56 ± 0.46 years, respectively. It should be noted that the number of children aged 0-5 years was 43(86%) in Group 1 and only 1(2%) in Group 2 ($P = 0.0000$). We found statistically significant differences for average age between Groups 1 and 2 in children aged 0-5 years (2.79 and 5.0, $P = 0.0000$). Thus, young children (from 0 to 5 years) are much more likely to suffer from ASOM than the older age group (from 6 to 16 years). In addition, children aged between 6-16 years accounted for 7(14%) in Group 1 and 49(98%) in Group 2 ($P = 0.000$), with an average age of 7.43 ± 0.45 years and 11.67 ± 1.05 years, respectively ($P = 0.0005$). Thus, the risk of developing a chronic purulent process in the ME increases sharply with the process of growing up in a child with an otogenic history, along with the growing threat of the spread of a purulent-septic focus and the development of life-threatening, intracranial otogenic complications.

Table 1.

LSI values in Groups 1 and 2 according to the age subgroups

Age subgroups (yrs)	Mean age		LSI		P-value
	Group 1 (n=50)	Group 2 (n=50)	Group 1 (n=50)	Group 2 (n=50)	
0-1	0.83 ± 0.09 (n=9)	0	1.20 ± 0.43 (n=9)	0	0
2-5	3.29 ± 0.17 (n=34)	5.0 ± 0 (n=1)	2.19 ± 0.28 (n=34)	0.75 ± 0 (n=1)	0.000
6-12	6.50 ± 0.37 (n=6)	9.27 ± 0.46 n=26	2.98 ± 0.82 n=6	1.34 ± 0.18 n=26	0.060
13-16	13.04 ± 0 n=1	14.46 ± 0.20 n=23	1.04 ± 0 n=1	1.74 ± 0.30 n=23	0.030

Table 2.

Descriptive statistics of the age in the study groups

Group	M	Me	Mo	SD	Cv,%	SEM
Group 1 (total, n=50)	3.44	3	4	2.22	64.46	0.31
Group 1 (age groups of 0-5 yrs, n=43)	2.79	3	4	1.33	47.83	0.20
Group 1 (age groups of 6-16 yrs, n=7)	7.43					0.45
Group 2 (total, n=50)	11.56	12	15	3.24	28.07	0.46
Group 2 (age groups of 0-5 yrs, n=1)	5.0	5	0	-	-	-
Group 2 (age groups of 6-16 yrs, n=49)	11.67					1.05

M, mean; Me, median; Mo, mode, SD, standard deviation; Cv, coefficient of variation; SEM, standard error of the mean.

Currently, the use of LSI for predicting otitis media in children has enough grounds for clinical use in practical healthcare, and widespread implementation in the algorithms of preventive examinations. The results obtained indicate that in children with mean age of 3.44 ± 0.31 years, the LSI level of 2.08 ± 0.23 can suggest the formation of ASOM. In children with mean age of 11.56 ± 0.46 years, the LSI level of 1.51 ± 0.16 can suggest the formation of CSOM.

At the same time, it is important to recognize the possibility of early diagnosis of the purulent process in the ME, both at the outpatient stage of diagnosis and upon admission to the ENT department of a children's hospital, which will allow adequate timely surgical treatment with the appointment of systemic antibiotic therapy and prevent the development of purulent-septic and intracranial complications.

To demonstrate the possibility of using LSI, we present two clinical cases.

Case Presentation 1

A 3.5-year-old boy was admitted on 07.18.2020 to the Department of Pediatric Otolaryngology for emergency indications. Complaints: pain in the left ear, fever up to 38.0°C , marked anxiety.

Anamnesis morbid

According to the mother's words, the child fell ill on 07.11.2020, when a pain in the left ear and fever up to 38.0° appeared. Outpatient treatment (amoxicillin, otipax) was prescribed by an ENT doctor. During treatment, the child's condition worsened.

Anamnesis vitae

Child from second full-term pregnancy, second childbirth, delivery at term. Body weight at birth – 4100 g. Past diseases: acute respiratory infections, chickenpox, bronchitis, tonsillitis, pneumonia. History of allergies is not burdened.

Clinical Findings, Diagnostic Assessment, and Treatment

General condition of moderate severity. Consciousness is clear. Body temperature - 38.0°C . The skin cover is clean, physiological color. The respiratory rate – 21 breaths per minute. The heart rate is 84 bpm. The abdomen is soft; the liver and spleen are not palpable. Urination is not disturbed. The stool is normal.

Local status

Nasal breathing is free.

Ears: Tympanic membrane of AD is grey, the cone of light is preserved; Tympanic membrane of AS is hyperemic, infiltrated, the cone of light is not preserved.

Diagnosis: Acute suppurative left-sided non-perforated otitis media

Standard laboratory diagnostic methods are performed. General blood test (07.18.2020): Segmented Neutrophils - 67%, Stabs - 5%, Basophils - 1%, Lymphocytes - 20%, Monocytes - 6%, Eosinophils - 2%, Platelets $206 \times 10^9/\text{l}$, Hemoglobin - 137 g/l Erythrocytes - $5.13 \times 10^{12}/\text{l}$, Leukocytes - $9.71 \times 10^9/\text{l}$. **LSI=2.8.**

Treatment: Paracentesis of the left tympanic membrane (of 07.18.2019) followed by conservative therapy.

Local status at discharge (07.26.2020).

Otoscopy: AS - the ear canal is free, the tympanic

membrane is gray, the identification marks are distinguishable; AD - the ear canal is free, the tympanic membrane is gray, the identification marks are distinguishable.

This clinical case shows that the LSI value of 2.8 in a 3.5-year-old boy is associated with the development of ASOM, requiring a surgical intervention followed by systemic antibiotic therapy.

Case Presentation 2

An 11-year-old girl was admitted on 10.14.2020 to the department of pediatric otolaryngology for emergency indications. Complaints: purulent discharge from the right ear, hearing loss on the right.

Anamnesis morbid

According to the parents' words, the child was sick for 10 days. when when the above-mentioned complaints appeared.

Anamnesis vitae

The patient grew and developed according to her age. History of allergies is not burdened. Past diseases: acute respiratory infections, chickenpox, acute right-sided suppurative otitis media (4 times from age 2), chronic right-sided suppurative otitis media in 2016. The child is under dispensary registration with an ENT doctor. Paracentesis of the rite eardrum in 2016. Contact with a novel coronavirus infection within the last 14 days is denied.

Clinical Findings, Diagnostic Assessment, and Treatment

General condition of moderate severity. Consciousness is clear.

Local status

Nose: nasal septum in the median position. Nasal breathing is moderately difficult. There is scanty mucoid discharge in the nasal cavity.

Oropharynx: mucous membranes are moist and pink; the pharynx is symmetrical.

Ears: The area of the mastoid process without features. AD: serous-purulent discharge in the ear canal; the tympanic membrane is edematous, grayish-cloudy, and perforated in the epitympanum. Tympanic membrane of AD is grey; the cone of light is preserved.

Diagnosis: Chronic epitympanic-antral suppurative otitis media.

Standard laboratory diagnostic methods are performed. SARS-CoV-2 IgM antibodies were not detected (10.14.2020).

General blood test (10.14.2020): Segmented Neutrophils - 48%, Stabs - 2%, Basophils - 0.4%, Lymphocytes - 33%, Monocytes - 7%; Eosinophils - 9%, Platelets - $335 \times 10^9/\text{l}$, Hemoglobin - 145 g/l, Erythrocytes - $4.98 \times 10^{12}/\text{l}$, Leukocytes - $7.96 \times 10^9/\text{l}$. **LSI=1.48.**

Treatment: Local and systemic antibiotic therapy for 5 days.

Local status at discharge (07.26.2020).

Rhinoscopy: the nasal passages are free, the mucosa is pink, clean.

Otoscopy: AS - the ear canal is free, the tympanic membrane is gray, the identification marks are distinguishable; the perforation in the epitympanum is dry, there is no discharge in the mastoid and tympanic cavity. AD - the ear canal is free,

the tympanic membrane is gray, the identification marks are distinguishable.

Pharyngoscopy: The pharynx is symmetrical; the mucosa is pink.

The patient was discharged with improvement.

This clinical case shows that the LSI value of 1.48 in a 11-year-old girl with a history of ASOMs is associated with the development of CSOM.

Thus, the method for predicting CSOM in children has enough grounds for clinical application in practical health care and widespread implementation in the algorithms of preventive examinations.

Conclusion

The listed diagnostic criteria typical for CSOM in children (history data, indicators of peripheral blood indices) can be calculated on an outpatient basis in pediatric practice, which is important for timely diagnosis, early treatment of the disease, and prevention of intracranial otogenic complications.

Competing Interests

The authors declare that they have no competing interests.

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