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Mini Review

Pathology of Pneumococcal Meningoencephalitis - Mini Review

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Abstract

Mini review summarizes the long-term studies of pathology of pneumococcal meningoencephalitis on children's, adult autopsy material and in experiment provided by the author and its collaborators. Pneumococcal meningitis in most severe cases includes brain matter lesions, to be considered as meningoencephalitis with high mortality. Nearby secondary lesions which can be regarded as complications of pneumonia, otitis and sinusitis, primary meningitis are not seldom. We can postulate the existence of highly virulent neurotropic strains of S. pneumoniae, leading to development of hypertoxic forms of the disease. The frequency of secondary brain lesions in pneumococcal pneumonia significantly arose during last decades.

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One of the most common pathogens of meningoencephalitis is pneumococcus (Streptococcus pneumoniae) was discovered in 1886. Recently appeared numerous contributions mostly devoted to several aspects of pathogen properties, epidemiology, elaborating of vaccines and treatment [1-4]. Histopathology of pneumococcal infections seems to the most of modern investigators to be well described in the first half of the XXth century [5-9]. We succeeded to demonstrate that certain views upon pathology of pneumococcal pneumonia have to be revised [10].

Bacterial meningitis is a worldwide health problem, with incidence rates ranging from approximately 0.9 per 100 000 individuals per year in high-income countries to 80 per 100 000 individuals per year in low-income countries. In low-income countries, bacterial meningitis has a mortality rate of up to 54%. Up to 24% of those who survive develop chronic neurological sequelae, such as hearing loss or focal neurological deficits. Streptococcus pneumoniae causes about 72% and Neisseria meningitidis causes about 11% of cases of bacterial meningitis in people older than 16 years [11]. All researchers emphasized the identity of changes in purulent meningitis of various etiologies [6-9,12,13].

V. A. Zinserling et al. [14], conducted a detailed study of 31 children who died from pneumococcal meningoencephalitis (PME). 6 children died during the first 6 months of life, 9 - in the second half of the year, 8 children aged from 1 to 3 years, 6 children - from 3 to 7 years, and 2 were over 7 years. Most of the children had a favorable anamnesis, only 1 child had Down's disease and 3 had perinatal brain damage. Previous severe bacterial pneumonia was not diagnosed in any child, catarrhal or purulent otitis media was observed in only 7 children. Several variants of the course of this disease were identified: a) hypertoxic course with duration of the disease till the death only 12-48 hours (6 observations); b) acute course with death on 3-7 days (20 observations); and c) with an acute course with transformation to chronic progredient and death after 10 days - 1.5 months from the beginning of the disease (5 observations). The hypertoxic course was characterized by the most acute symptoms of neurotoxicosis - persistent hyperthermia, progressive impaired consciousness, shortness of breath, tachycardia, pallor, and after 7-20 hours - convulsive-comatose and meningeal syndrome with respiratory and cardiovascular disorders. 5 patients had a small-point hemorrhagic rash. Lumbar puncture was performed in 5 patients, in 3 of them purulent CSF was obtained, in 2 opalescent with protein-cell dissociation. The acute course of PME, there was a sharp deterioration in the condition in the form of an increase in general cerebral symptoms, autonomic disorders, central hyperthermia, and on the 3-4 day, as a rule, developed a comatose-convulsive syndrome with pronounced meningeal syndromes. Upon admission to the clinic, diencephalic-mesencephalic coma was diagnosed in 15 patients, lower-stem coma - in 12. Lumbar puncture was performed in 16 patients, 10 of them had purulent cerebrospinal fluid, and 6 - protein-cell dissociation. A chronically progredient course was observed in 5 patients with a long stay on artificial lung ventilation. Already 5-7 days after the onset of the disease, symptoms of decortication and decerebration occurred, and neurotrophic disorders progressed. Pneumoencephalography revealed internal and external hydrocephalus, the phenomenon of cystic arachnoiditis. The etiological diagnosis was made on the basis of in vivo and postmortem bacteriological studies. It was possible to type the pathogen in 9 cases. 5 strains belonged to serotype 1, 2 - to serotype 2, one each to serotypes 1 and 19.

V. D. Zinserling [15] gives statistics of complications in croupous pneumonia. Thus, meningitis, as the most dangerous complication, occurs in 6 % of cases. At first, it proceeds as serous, then it becomes fibrinous-purulent or purulent. We analyzed 152 deaths from pneumococcal pneumonia in Irkutsk [10]. Damage to the soft meninges was noted in 17 cases (11.2%), of which meningoencephalitis occurred in 9 cases, accompanied by ventriculitis in 5 cases. In one case ventriculitis was complicated by hemorrhage in the vascular plexus. The pia mater, in cases of meningitis and meningoencephalitis, was sharply edematous, cloudy, green-yellow in color with a gray tinge. Microscopically, there was pronounced edema, circulatory disorders in the form of plethora, infiltration by white blood cells, fibrin in the form of threads, films, infiltrated by white blood cells were visible on the outer surface of the membrane. In cases of meningoencephalitis, vascular damage was noted. When stained with azur-eosin, lanceolate diplococcus was determined. In smears-prints – Gr+ diplococcus. In 7 cases with meningitis, pneumococcus was detected in culture.

In the SP Botkin infectious hospital, we analyzed, 269 deaths from croupous pneumonia [16]. Among the deceased, men were strongly predominant – 208 (77.3%). Information about chronic alcoholism was available in the patient's records in 227 cases (84.4%). In many cases, the nature of the structural changes of the lungs indicated a longer duration of the disease than was evident from the scanty medical history. In almost all cases, fibrinous or fibrinous-purulent pleurisy was noted. Purulent meningitis and meningoencephalitis as complication were diagnosed 68 times (25.3%). These data indicate that over the past half century, the frequency of purulent meningitis and meningoencephalitis as a complication of croupous pneumococcal pneumonia has increased by 2-4 times. During the same period of time, 44 patients with secondary purulent meningitis with other primary foci, including 13 polysinusitis and 3 otitis media, were examined. Despite the lack of direct bacteriological data in some cases, it can be confidently assumed that pneumococcus was the causative agent in the vast majority of these observations. Almost all of the patients were middle-aged and elderly with a slight predominance of men. Morphologically significant differences from the primary meningoencephalitis were not revealed, they were naturally accompanied by ventriculitis and vasculitis of the cerebral vessels. Pneumococcal purulent meningitis may be complicated by subdural empyema. In this case, the changes are localized, as a rule, along the convex, possibly along the interhemispheric gap. Empyema is rarely two-sided.

Experimental pneumococcal meningoencephalitis is since 20-30th of the XX century traditionally reproduced by suboccipital challenge of rabbits. In order to study some aspects of the pathogenesis of PME, we [14] conducted an experimental study on 18 rabbits. Animals were challenged suboccipitally with a dose of $1x10^5$-$2x10^5$ microbial cells per animal. Three strains of pneumococcus were used for infection: 1) a serotype 1 strain isolated from the brain of a girl who died from PME within a day from the onset of the disease; 2) a serotype 27 strain isolated from the cerebrospinal fluid of a boy who had a moderate form of the same disease; 3) an atypical one isolated from the ear of a patient without a clinical picture of otitis media. All animals infected with pneumococcus serotypes 1 and 27 developed meningoencephalitis on day 1, characterized by an increase in body temperature, loss of appetite, and convulsive twitching of the limbs. By the end of two days, all 9 animals infected with serotype 1 pneumococcus had died. 6 animals infected with pneumococcus serotype 27 fell by the end of 3 days, 1 rabbit after 4 days. Morphological examination of all animals revealed massive, mainly granulocytic, infiltration of the soft meninges. However, the changes caused by pneumococcus serotype 1 were significantly more pronounced: in these animals, a large number of microbes were detected histobacterioscopically in the soft meninges, and there was a clearly pronounced hemorrhagic syndrome, both in the soft meninges and in the brain substance. Granulocytic infiltration was naturally determined around the vessels in the brain substance, in the villi of the choroidal plexus, and subependymal, including in the area of the hippocampus. When animals were infected with an untyped strain of pneumococcus, even in very significant doses ($1x10^9$ microbial cells per animal), their condition did not significantly worsen. At the control slaughter of 2 animals on the 10th day, they had only a rather loose mononuclear infiltration of the soft meninges. Effective complex treatment, including penicillin (to which the studied strains were sensitive) and transfusion of liquor, was accompanied by the appearance of focal perivascular mononuclear infiltration in the soft meninges.

RESULTS

Thus, the results of our long-term investigation allow to postulate that pneumococcal meningitis in most severe cases includes brain matter lesions, to be considered as meningoencephalitis with high mortality. Nearby secondary lesions which can be regarded as complications of pneumonia, otitis and sinusitis, primary meningitis are not seldom. We can postulate the existence of highly virulent neurotropic strains of S. pneumoniae leading to development of hypertoxic forms of the disease. The frequency of secondary brain lesions in pneumococcal pneumonia significantly arose during last decades.

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