EXPERIMENTAL MUMPS MENINGITIS.

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Meningitis or meningoencephalitis is a complication of parotitis which occurs in children as well as in adults. The incidence varies greatly. The highest number of cases recorded is 16 among 653 mumps patients observed by de Massary, Tockmann, and Luce, while none occurred among 1,059 soldiers seen by Brooks. It may be said that while mumps meningitis is of rare occurrence, it appears with sufficient frequency to be kept in mind by everyone called upon to treat patients ill with parotitis. The nervous symptoms may precede or follow the parotid swelling. More often, however, symptoms of meningeal irritation develop during the height of the parotid lesion.

In work on experimental parotitis in cats, it seemed interesting to attempt to produce meningitis by means of the virus which caused the characteristic lesions in the salivary glands in the inoculated animals. With four strains of active virus, intrathecal inoculations gave only negative results in ten cats. Finally, a virus was obtained from the mouth secretions of four children on the 2nd and 3rd days of an attack of typical parotitis. The filtrate from the pooled mouth washings was inoculated into the parotid glands of two cats and into the subarachnoid space of two others. All the animals used in these experiments were young cats of medium size. The two which had been inoculated into the parotid gland developed typical signs of parotid swelling, leucocytosis, and fever. When killed on the 16th day, the parotid, submaxillary, and adjacent lymph glands were swol-
len, congested, and moist. Microscopically, they showed the epithelial swelling, edema, and interstitial infiltration characteristic of human and experimental parotitis. A protocol of an intrathecal inoculation experiment follows, and is typical.

Cat A.—Mar. 10, 1921. Temperature 38.4°C. Subarachnoid occipito-atlanto-toid puncture withdrew clear fluid, containing no cells and giving a negative globulin test with the Noguchi method. Cultures proved negative on ordinary media. 1 cc. of sterile mouth filtrate pooled from four cases of mumps, 1 and 2 days in duration, was injected.

Mar. 11. The cat is quiet and refuses food. There is internal strabismus of the left eye. The animal walks slowly, but there is no paralysis. No convulsions. Puncture of the cisterna magna withdrew 1.5 cc. of turbid fluid under greatly increased pressure. No bacteria were seen in spreads, and cultures did not grow. Globulin +++; there were 22,000 cells, of which 84 per cent were polymorphonuclears and 16 per cent mononuclear leucocytes.

Mar. 12. Temperature 40°C. Strabismus is more marked. The cat walks only when disturbed, and is irritable when handled. No convulsions. Cerebrospinal fluid is still turbid, containing 18,000 cells, of which 66 per cent are polymorphonuclears. Globulin ++. Cultures did not grow, aerobically or anaerobically.

Mar. 14. Temperature 40°C. The animal is prostrated and the strabismus is still present. Puncture of the cisterna magna withdrew fluid under increased pressure, but almost clear. The cells numbered 500. Globulin +. Cultures remained sterile.

Mar. 15. Temperature 39.9°C. Cerebrospinal fluid clear. The strabismus has disappeared. The cat is thin.

Mar. 16. Temperature 39°C. Though thin and quiet, the animal is apparently well.

Another cat injected into the subarachnoid space with this same strain of parotitis virus gave symptoms similar to those described above, and was killed with chloroform on the 3rd day. The pia mater over the cortex was found to be cloudy but no exudate was present. The vessels of the pia mater were deeply congested over all surfaces of the brain. The ventricles were not dilated. Anaerobic and aerobic cultures proved negative. Microscopic examination showed that all the vessels were filled with blood cells and edema of the pia was marked. There were only a few small groups of polymorphonuclear cells around some of the smaller vessels. The lesion of the pia mater is mild in character just as the lesion of the parotid is.

It is possible, then, by injecting sterile mouth filtrate from early mumps cases into the subarachnoid space of cats, to cause signs of meningeal irritation. These are: increase in the amount of cerebrospinal fluid with an abnormal content of cells and globulin, increased intrameningeal pressure, and consequent symptoms of irritability, ocular irregularity, prostration, and fever.

It remained to attempt to transmit the meningeal lesion from one cat to another. This was done with the cerebrospinal fluid from Cat A and from one other cat which had reacted characteristically. The following is a typical protocol of such a transmission experiment.

*Cat B.*—Mar. 21, 1921. Temperature 38.6°C. Occipito-atlantoid puncture withdrew clear fluid, containing 20 cells and reacting negatively to a test for globulin. Cultures did not grow. 0.5 cc. of slightly turbid, sterile, cerebrospinal fluid obtained from Cat C on the 3rd day after occipito-atlantoid inoculation with active mumps virus was injected into the cisterna magna.

Mar. 22. Temperature 40.3°C. The animal lies in the back of the cage and refuses food. No paralyses are apparent. The left pupil is more widely dilated than is the right. On puncture of the cistern, turbid cerebrospinal fluid escapes under high pressure. Only 0.5 cc. could be caught in a test-tube, and it contained an increased amount of globulin with 2,300 cells, of which 80 per cent were polymorphonuclear leucocytes. Cultures proved negative.

Mar. 23. Temperature 40°C. The animal is still quiet, the cerebrospinal fluid is less turbid, and globulin +. No bacteria present.

Mar. 24. Temperature 39.5°C. The eyes are normal. The cat walks slowly and the appetite is improved. Cerebrospinal fluid is clear and sterile.

Recovery would seem to be the rule in these cases. The only animal which died succumbed on the 2nd day because in puncturing the cisterna magna the needle entered the medulla.

Three controls were made. Sterile salt solution was injected into the cisterna magna of a cat and caused no symptoms other than a mild rise in temperature of 0.8°C. for 1 day; the cerebrospinal fluid withdrawn was clear. Another control was made by injecting into the cisterna 1 cc. from a sterile, fluid, anaerobic culture which had been inoculated 10 days before with sterile extract from the experimentally swollen parotid gland of a cat. The injection was followed by no symptoms. The temperature rose only 0.4°C. The cerebrospinal fluid of the cat remained clear, sterile, and without a demonstrable amount of globulin. The animal was not prostrated, nor did it lose weight. The third control was made with the filtrate of
saliva from a normal individual; the injected cat developed no symptoms.

The second control was for the purpose of noting the effect of the injection of a fluid rich in protein on the meninges, since the culture medium was human ascitic fluid.

The sterile filtrate from the mouth washings of patients suffering from an attack of parotitis of 1 or 2 days duration, when injected into the cisterna magna of young cats by occipito-atlantoid puncture, causes signs and symptoms of meningitis of 3 to 5 days duration, which end in recovery. The picture resembles that of mumps meningitis as it occurs in human beings, but differs from it in the high polymorphonuclear cell reaction as evidenced by the cerebrospinal fluid. Flexner and Amoss* showed that the injection of sterile horse serum into the subarachnoid space of monkeys caused an aseptic inflammation of mild degree, which reached its maximum in 24 hours. Polymorphonuclear cells predominated in the exudate. A polymorphonuclear reaction was also found by Ayer7 in aseptic meningitis caused by the injection of normal rabbit serum into the meninges of cats; but this meningitis was of only 1 day’s duration and accompanied by no general symptoms. However, the fact that in our experiments neither sterile salt solution, sterile ascitic fluid, nor sterile saliva from a normal person caused the meningeal reaction brought about by the injection of the filtrate containing an active mumps virus, would seem to argue that the reaction caused by the filtrate was due to some factor other than either albuminous fluid or salt solution.

**SUMMARY.**

It has been shown that an aseptic meningitis of 3 to 5 days duration and favorable prognosis can be induced in cats by intrathecal injection of sterile saliva filtrate from early cases of parotitis, and that such a meningitis can be transmitted to other cats by injecting the cerebrospinal fluid in the same manner. The cerebrospinal fluid does not, at any time, contain bacteria which grow with the ordinary culture methods.