A Ventriculoscope and Its Application for Experimental Neuroanatomy

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Summary

By using a type III ventriculoscope for animal experiment *(Yamadori)* which can be inserted from the cisterna cerebellomedullaris, the interior of the fourth and third ventricles of dogs was observed, and lesions were produced in the adhesio interthalamica and midbrain tegmentum by discharge of 4 mA current for five seconds to the sheath of the ventriculoscope which is designed as an electrode. By this experiment, it was demonstrated that this 2.0 mm calibered fiberscope is effective in producing lesions accurately on the wall of the ventricular system without highly affecting the neighbouring structures.

Key-Words: Ventriculoscopy, experimental neuroanatomy, encephaloscopy.

Ventrikuloskop und dessen Anwendung bei der experimentellen Neuroanatomie

Mit dem Typ-III-Ventrikuloskop für Tierversuche *(Yamadori),* das durch die Cisterna cerebromedullaris eingeführt werden kann, wurde der Innenraum des 3. und 4. Ventrikels betrachtet. Mit 4 mA für 5 Sekunden wurden in der Adhaesion interthalamica und dem Tegmentum Läsionen gesetzt, wobei der Schaft des Ventrikuloskops als Elektrode diente. Dabei ließ sich zeigen, daß mit dem 2,0 mm dicken Fiberskop in der Wandung der Ventrikel präzis lokalisierte Läsionen gesetzt werden können, ohne daß Nachbarstrukturen alteriert werden.

Introduction

At present *Nauta-Gygax* (5) or *Fink-Heimer* (2) techniques are very popular in tracing degenerating nerve fibers in the field of neuroanatomy. By these silver impregnating techniques one can microscopically examine various fiber connections in the central nervous system and innumerable works using these techniques have been published in recent years. As the main procedure of the experiment using these techniques is the production of a lesion in a certain nucleus of the central nervous system and letting the animal survive for about a week and then tracing degenerating nerve fibers by the selective silver impregnating technique, the most important thing is to produce a lesion accurately in the intended nucleus that might be the origin of degenerating nerve fibers, without highly affecting the neighbouring structures. Electrocoagulating technique (1) or ultrasonic ray (3) is commonly used for this purpose, but they are not decisive in fulfilling the original purpose. Therefore, a small-calibered flexible ventriculoscope of which a sheath plays the part of an electrode and can be inserted into the fourth and third ventricles through the cisterna cerebellomedullaris had been developed. By the experiment using this ventriculoscope, the authors found that it is possible to place the lesion on any structure which form the wall of the fourth ventricle, cerebral aqueduct and the upper part of the third ventricle.

Materials and Methods

For this experiment thirteen adult dogs of various kinds were used. These animals had sufficient brain size for the insertion of the ventriculoscope and there was no inconvenience in producing lesions in the brain due to the slight difference of size and shape of the brain between them. Among thirteen dogs the lesion was successfully placed either in the

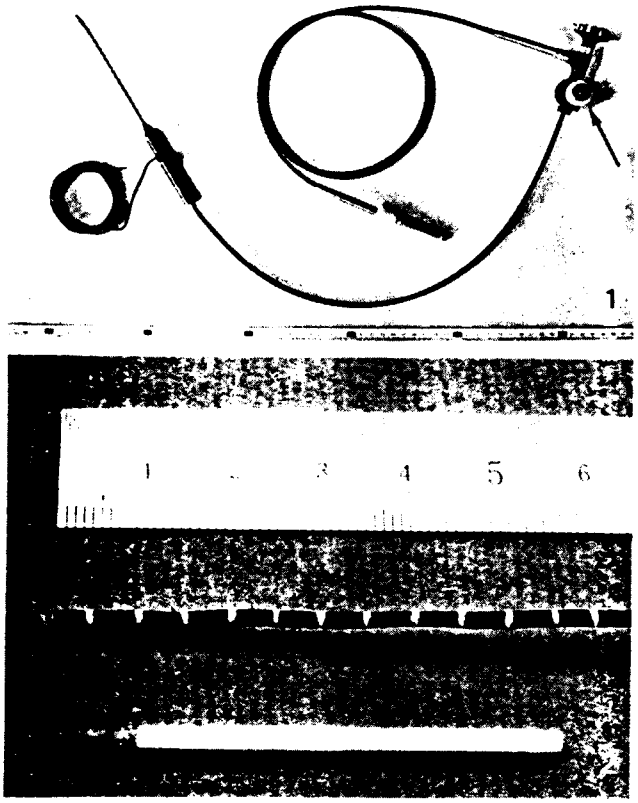

Fig. 1 Type III ventriculoscope. Arrow shows the dial to control the movement of the flexible part.

Fig. 2 Flexible part of the ventriculoscope.

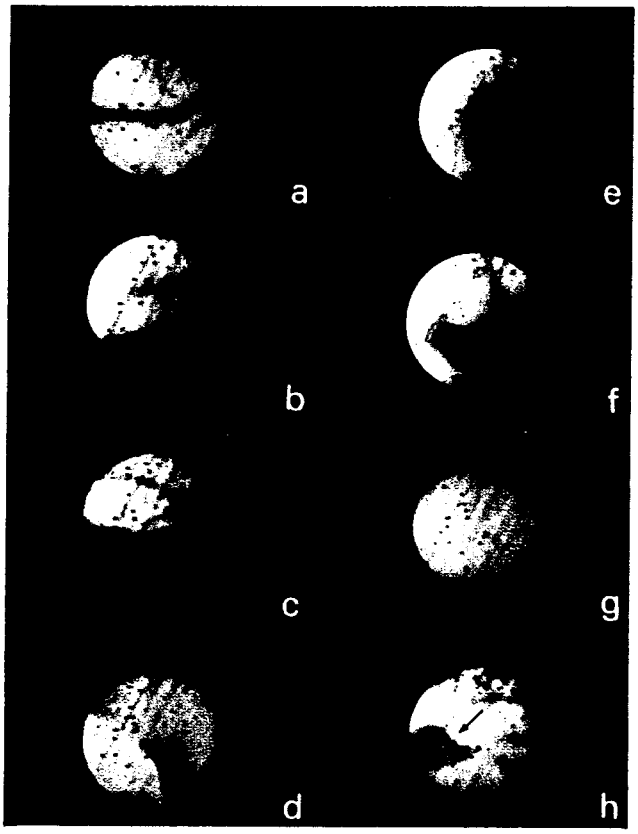

Fig. 3 a–h Ventriculoscopical views of the dog brain.

Fig. 3 is made with an Instrument of Machida, Munich.

a) Shows the entrance to the fourth ventricle. The upper half is the vermis of the cerebellum and the lower half is the medulla oblongata. Blood vessels are seen on both structures.

b) Shows the interior of the fourth ventricle. A stria of blood vessel is seen between two folia of the cerebellum. The floor of the fourth ventricle looks dark.

c) Shows striae of blood vessels on the cerebellar cortex.

d) Shows the entrance to the cerebral aqueduct.

e) Shows the interior of the cerebral aqueduct. Only the wall of the cerebral aqueduct is seen as a pale crescent structure.

f) Shows the entrance to the third ventricle where a pair of mamillary subcommissural organ is always seen.

g) Shows the posterior end of the adhesio interthalamica in the third ventricle.

h) Shows the coagulated lesion (arrow) on the adhesio interthalamica.

adhesio interthalamica or in the midbrain tegmentum in nine cases. However, in two cases it was impossible to produce the lesion due to bleeding in the fourth ventricle which had been caused by injury of the choroid plexus and in the other two cases the animals could not survive until the sacrificing day probably due to failure of the operation. This success rate of the operation was better than the experiment using the type II ventriculoscope in which the lesion was successfully placed in the brain in twelve cases among sixteen surviving cases.

The fiberscope used was type III ventriculoscope for the animal experiment which had been planned by Yamadori as an improvement upon type I (8) and type II (9) ventriculoscope for the same purpose and was constructed by Machida Manufacturing Co. in Tokyo. The main performance of this ventriculoscope compared to type II is shown in Table 1. Both types of ventriculoscope are equipped with the lens system of ten times of enlargement and 2 mm of visual distance.

Table 1 The performance of the ventriculoscopes.

	type III	type II
total length	830 mm	780 mm
flexible part/inserting part	80/130 mm	50/100 mm
flexible part diameter	2.0 mm	2.3 mm
flexion angle	up 30°, down 10°	up 20°, down 10°

Prior to the observation and coagulation, the animal was fixed on the Todai type stereotaxic apparatus under nembutal anaesthesia and the atlanto-occipital joint was surgically opened from the nuchal side and a small incision, for the insertion of the ventriculoscope, was made on the dura mater and arachnoid of this portion. At the insertion of the tip of the ventriculoscope, the whole equipment was fixed on the stereotaxic apparatus and the inserting part of the ventriculoscope was moved forward, under mechanical control, into the fourth ventricle and then into the third ventricle through the cerebral aqueduct. In photography, Olympus pen-F camera and Machida RM-300 light supplying equipment were used.

Results

The ventriculoscopical views are shown in Fig. 3. To insert the ventriculoscope into the third ventricle, the observer must let the ventriculoscope pass through the fourth ventricle and the cerebral aqueduct. However, the identification of these structures are not so difficult as they have their own characteristics. For instance, it is difficult to find blood vessels on the floor of the fourth ventricle, while a few striae of blood vessels are seen on the cerebellar cortex in the dorsal direction. The recognition of the cerebral aqueduct is very easy as it is a narrow path and the wall looks pale due to the lack of blood vessels. The gate between the aqueduct and the third ventricle is not so difficult to identify as a pair of mamillary swellings of the subcommissural organ are always suspending at this portion. When the ventriculoscope passes through the gate. it faces the large gray mass of interthalamic adhesion. When the tip of the ventriculoscope

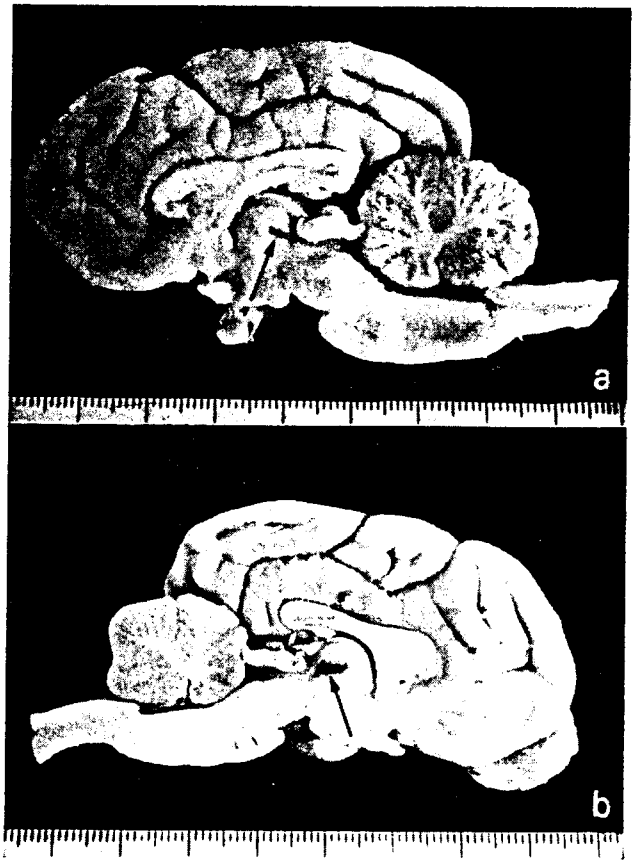

Fig. 4 a and b Artificial lesions (arrows) in the thalamus (adhesio interthalamica). a) Shows a mechanically produced lesion by insertion of the ventriculoscope. b) Shows an electrically coagulated lesion.

Fig. 5 Electrically coagulated lesion (arrow) in the nucleus centralis medialis of the thalamus. From the silver impregnated slide. ×2.5.

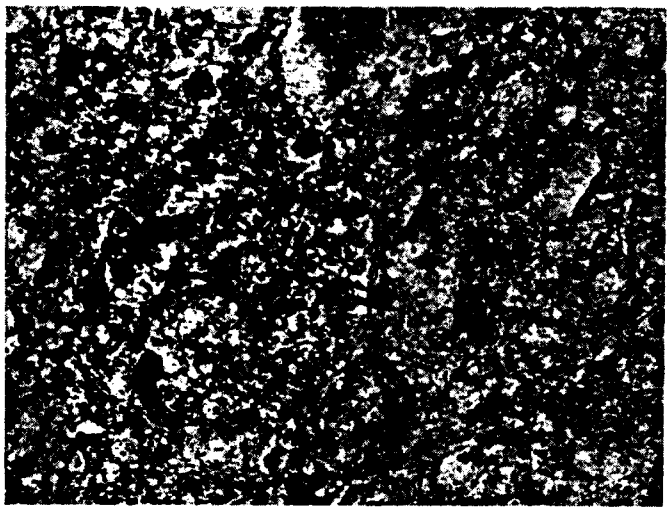

Fig. 6 Degenerating nerve fibers seen in the intact portion of the nucleus centralis medialis of the thalamus. ×370.

is pulled up, there appears a narrow cleft formed by the dorsal portion of the thalamus. If the ventriculoscope is inserted more deeply forward, one can observe the interventricular foramen and the rostral wall of the third ventricle.

Fig. 4 (a, b) shows the lesion being made by the type III ventriculoscope. In the case of Fig. 4 a the ventriculoscope was only mechanically inserted into the interthalamic adhesion, while in the case of Fig. 4 b 4 mA current was discharged for five seconds to the sheath after the insertion of the tip. From this figure it can be easily recognized that other portions are intact. For this reason, the tracing of degenerating nerve fibers is much easier than the cases in which the lesion is produced by the insertion of an electrode from the cranial surface. Fig. 5 shows the same lesion in the section of 35 μ thickness. As the lesion had been placed in the nucleus centralis medialis of the thalamus in this case, it is possible to know the efferent fibers of this nucleus by tracing the degenerating nerve fibers. The black dots in the section of figure 6 show the selectively impregnated degenerating nerve fibers by *Nauta-Gygax* technique in the intact portion of the nucleus centralis medialis.

Discussion and Conclusion

Although *Putnam* (7) applied the ventriculoscope, the modified cystoscope, to the coagulation of the choroid plexus, this kind of endoscope had not been commonly used until the recent development of techniques for making glassfibers. Presently a new kind of glassfiber encephaloscope (6) and endoscope (4) have been introduced into the clinical field, but a special flexible fiber ventriculoscope for animal experiment has not been developed.

The present ventriculoscope can produce lesions on the wall of the fourth ventricle, cerebral aqueduct and the upper portion of the third ventricle without affecting other parts of the brain. Above all, as one can produce the lesion under observation of the ventriculoscope, the lesion can be placed accurately without being affected by the size or shape of the brain. The authors think that this kind of ventriculoscope is fit not only for the production of lesions in experimental neuroanatomy but also for clinical examination and treatment.

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