A chronic cannula for obtaining CSF from the cisterna magna of awake dogs

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JENNINGS, D. B., AND P. TOBIN. A chronic cannula for obtaining CSF from the cisterna magna of awake dogs. Am. J. Physiol. 236(1): R132-R134, 1979 or Am. J. Physiol., Regulatory Integrative Comp. Physiol. 5(1): R132-R134, 1979. — We have designed a cannula system that can be chronically implanted to end above the dura of the cisterna magna of the dog. During experiments in the awake dog, a screw cap with stylet is removed from the cannula and a spinal needle inserted for the withdrawal of samples of cisternal cerebrospinal fluid (CSF) or for making continuous measurements of pressure. The system can be used for repeated experiments extending over several weeks.

We have been interested in studying the composition of the cisternal cerebrospinal fluid (CSF) in awake dogs in relation to the regulation of respiration during acute and chronic respiratory acidosis. An implantable cisternal cannula system has been designed for the dog that is a modification of systems described by other workers (1-4).

Design of components of cannula system

Baseplate to hold the cannula (see Fig. 1). A U-shaped stainless steel plate is attached to the posterior skull around the parietal crest (insert above Fig. 1A). An extended projection bent downward and parallel to the plate contains a tapped hole (6-32) into which the cannula is screwed. The length of the arms of the plate is 15 mm; the distance between the arms varied from 6 to 15 mm to fit different dogs; the width of each arm is 7 mm and the holes in the arms (no. 34 drill) will accept round-headed machine screws (4-48) of 5-mm length. Some plates are prepared with the arms angled to fit a laterally sloping skull.

Guide tube for drill used in making a hole for tip of shaft of cannula in bone at base of occipital bone (Fig. 1A). The shaft of a no. 13-gauge needle is cut to a length of 3 cm and the hub of the needle near the shaft is threaded (6-32) to fit into the cannula screw hole of the plate.

Cisternal cannula (Fig. 1, B and C). The shaft for the cannula is made from no. 15-gauge hypodermic tubing cut to a length of 8 cm. The hub for the cannula is machined from stainless steel to an external diameter of 7 mm. Hubs of varying lengths (2-3 cm) allow for different neck muscle thicknesses in the dogs. The center of the length of the hub is drilled (no. 49) to accept the shaft that is welded in with silver solder. The other end of the hub is drilled and threaded (10-32) to accept a machine screw cap with a socket for an Allen wrench (5/32 in.). A stylet to fit into the cannula is soldered into the center of the machine screw. The sides of the upper end of the cannula are machined flat to accept a small wrench (7/32 in.), which is used to tighten the cannula to the plate and which can be used during experiments, if necessary, to hold the cannula when removing the screw cap.

Sampling needle system (Fig. 1C). Cerebrospinal sampling needle systems are made from no. 22 spinal needles whose shafts are cut about 2-3 cm below their hubs. The two parts of the shaft are joined by snugly fitting polyethylene tubing (length 10-15 cm). A 3-mm thick disc hub, the same diameter as the cannula hub, has a hole drilled in its center to accept the no. 22-gauge needle. A setscrew (2-56) fixes the disc hub on the needle shaft to set the maximum length of the needle beyond the tip of the cannula into the cisterna magna. The components of the sampling system are packaged together and gas sterilized.

Screw-in-stabilizer (Fig. 1C). To hold the needle sampling system in the cisternal cannula a similar disc hub is prepared as described in the previous section, but, in addition, it is threaded (10-32). It is inserted into the top of the cannula prior to inserting the sampling needle. When the sampling needle has been adjusted to obtain a flow of cerebrospinal fluid, the setscrew of the "screw-in-stabilizer" is tightened to hold the sampling needle firmly in place.

Surgical procedures

At the operation to implant the cannula system, the dog’s head is held by ear bars in a stereotaxic frame (Kopf Instruments no. 1504) and the head is flexed ventrally. A midline skin incision is made 4-5 cm along
CISTERNAL CEREBROSPINAL FLUID CANNULA

Fig. 1. A: guide tube in plate attached to skull and drill for making hole in shelf of occipital bone above cisterna magna. Insert (upper left) shows positioning around parietal crest of plate for holding cisterna cannula. B: cisternal cannula complete with its screw cap for times between experiments. Screw cap also has a stylet that fits down the shaft of cannula. C: sampling system inserted into cisternal cannula. Screw-in-stabilizer is screwed into end of cisternal cannula and its setscrew is holding spinal needle. Disc-hub is attached to spinal needle to prevent it from protruding beyond end of cannula more than the desired distance.

Fig. 2. Continuous measurement of cisternal CSF pressure in conscious dog with Statham P23Db strain gauge held at a fixed position beside dog. Pressure zero point at bottom of the cisternal cannula is calculated in each panel for position of dog relative to transducer. Expiratory airflow and tidal CO2 pressure were measured from endotracheal tube in a chronic tracheostomy opening.

The place for holding the cannula is selected for the size and shape of the head and bent with pliers as required. The guide tube for the drill is screwed into the plate and a drill (no. 50) inserted to test whether the angle of the plate projection that holds the cannula is aimed at the shelf of bone at the base of the occipital bone. The angle of the projection of the plate is adjusted with pliers so that the drill is on the bony ledge within 2-3 mm of the atlanto-occipital membrane. At this point, holes are drilled into the parietal bone on the top...
of the skull and the plate is attached by screws to the skull. With the guide tube screwed into the plate, the hole at the base of the occiput is gently drilled by hand until the drill is felt to just pass through the bone (Fig. 1A). Using the drill length, the shaft of the cisternal cannula with the screw cap and stylet inserted is cut to the appropriate length. The cisternal cannula is then screwed into the plate with the shaft of the cannula inserted into the drilled hole in the occipital bone shelf above the cisternal magna. Dental cement (Nuweld) is poured down around the screws in the occipital bone and around the shaft of the cisternal cannula below the plate (see Fig. 1, B and C).

It is important to bandage the head leaving the ears free. Orthopedic stockinette (4 in. wide) held by masking tape and with slits for ears is a convenient way to enclose gauze bandaging on the head.

CSF SAMPLING AND PRESSURE MEASUREMENT

Cerebrospinal fluid can be sampled within a few days of operation. At present, essentially 100% of our implants are successful. Initially, we had unsuccessful implants if the tip of the cannula was inserted too far rostrally and not as close to the atlanto-occipital membrane as possible. The major time-limiting factor for sampling from this system is the gradual growth of tissue below the tip of the cannula. We have found that successful taps can be made routinely for 6-8 wk, and in some cases, we have carried out repeated successful taps for twice as long.

Bubble-free samples of CSF for acid-base measurements can be obtained with this system. Dogs have postspinal headaches when 4-5 ml of fluid are withdrawn more than twice over a 2-h period. We generally restrict ourselves to a sample of 4 ml and will repeat this once after a 1-h period. There has been no indication of outward leaking of CSF around the sampling needle.

An example of continuous measurement of CSF pressure using the system is depicted in Fig. 2. As shown in the first panel, the dog was panting when breathing air and was in a head-up sitting position so that CSF pressure was about -16 Torr. The dog then inhaled 5% CO₂ in air with an increase of CSF pressure to a less negative level. The changes in CSF pressure with changes in posture are shown in subsequent panels. As well, the variations in CSF pressure with respiratory pattern are clearly evident.

COMPLICATIONS

The dogs are up and eating within 24 h. They have a sore neck following the operation but in most this disappears following healing. A membrane surface surrounds the cisternal cannula and has a small amount of fluid secretion. The area is cleaned regularly with saline and if local infection occurs it is flushed with peroxide and local antibiotics applied. We protect the projecting cannula by cushioning it with gauze held in place with stockinette. We have had two instances of stiff neck and fever, presumably secondary to localized meningitis, that have responded promptly to antibiotics.

REFERENCES


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