Lateral Ventricular Cerebrospinal Fluid Pressure of Holstein Male Calves Measured in a Sternal Recumbent Position Under General Anesthesia

Abstract
Lateral ventricular cerebrospinal fluid, CSF, pressure was measured in 58 calves ranging in age from 18 through 160 days. Average live weight was estimated to be 46 kg at 18 days of age, 158 kg at 160 days, with 7-day increases amounting to 6.2%. CSF pressure increased each 7 days by 2.5 mm of synthetic CSF and was represented by the following linear regression equation: \( Y_2 = -1 + .364X \), \( r = .44 \), in which \( Y_2 \) = CSF pressure in millimeters of synthetic CSF and \( X \) = days of age. At 18 days of age, the pressure was estimated to be 6 mm and at 160 days, 5 mm. Because of the unequal distribution of calves across all ages, no data between 76 and 138 days and beyond 160 days, the relationships between CSF pressure and age were considered tentative. This is especially so in light of previous observations that with advancing age cisternal CSF pressure of anesthetized calves in lateral recumbency plateaued at ages greater than 101 days. Possible cause(s) of the increasing CSF pressure with increasing age was discussed.

Introduction
Cerebrospinal fluid (CSF) pressures of normal animals and man, measured under a particular set of conditions, including site of entry into the CSF space, position and restraint of the animal, with or without anesthesia, and procedures and equipment employed in the measurement, are maintained within reasonably defined limits (2). Fankhauser (3) summarized information on normal CSF pressures of cattle including measurements in standing unanesthetized cattle obtained by either cisternal or lumbar puncture and in lateral recumbency by cervical puncture. Calhoun et al. (1) reported that in Holstein male calves, ranging in age from 5 through 191 days, cisternal CSF pressure measured in lateral recumbency under general anesthesia, increased 6.7% per 7 days from a geometric mean pressure of 93 mm of saline at 5 days to 224 mm at 101 days of age and at older ages did not increase, being maintained at a geometric mean pressure of 224 mm of saline. Most recently Frier et al. (5) observed average lateral ventricular CSF pressures of 14 mm of synthetic CSF in a group of 8 calves under general anesthesia and in sternal recumbency and average age 41 days versus 52 mm for 26 calves under the same conditions but whose average age was 149 days. The purpose of the present study was to estimate the change in CSF pressure with increasing age of calves utilizing data from normal animals employed in ventriculocisternal perfusion studies (4, 5).

Experimental Procedures
Fifty-eight Holstein male calves were raised to the sixth week of age on limited whole milk, limited calf starter, and ad libitum chopped alfalfa hay and water and thereafter on a vitamin A depletion ration plus adequate but not toxic intakes of vitamin A. At designated ages, and after withdrawal of feed from 16 to 18 hr, each calf was anesthetized with sodium pentobarbital, its trachea intubated, and then placed in sternal recumbency with its head in a fixed position. The rumen of calves older than 138 days was cannulated (8 mm diameter cannula) to eliminate possible increases in intraruminal pressure. A cannula guide was placed into the frontal bone followed by insertion of a needle (Becton, Dickinson and Company, 18 gauge 7.62-cm Quincke-Babcock spinal needle) through the cannula guide, into the left lateral ventricle. After connecting the needle to an open-end glass manometer containing synthetic CSF, the pressure was recorded every 30 sec for 10 min. The average of either the last nine or ten readings was used as the calf's pressure. Procedural details or references citing these are contained in two previous publications (4, 5).

Results and Discussion
Live weight obtained prior to anesthetizing each calf and representing a range in ages from 18 through 160 days increased an average of 6.2% per 7 days. This was expressed as follows (7):
$Y_1 = 1.60 + .003734 X \pm .04, r = .97$
in which $Y_1 = \log_{10}$ of live weight in kilograms and $X =$ days of age.

As to trend with the findings of Calhoun et al. (1) for anesthetized calves in lateral recumbency. Due to the lack of data between 76 and 138 days of age or possibly at ages greater than 160 days, delineation of ages at which CSF pressures would be expected to have a tendency to no longer increase or plateau was not possible. Sykes and Moore (8) could find no consistent trend in cisternal CSF pressure with age of unanesthetized calves in the standing position, and Calhoun et al. (1) reported the same findings for pressures taken similarly to those of Sykes and Moore (8). In both of these studies (1, 8), CSF pressures were not taken at early ages. In Fankhauser’s review of bovine CSF pressure (3), age was not mentioned and most recently Hayes and Corey (6) reported no discernible age trend in CSF pressure of rats (body weight range 200 to 550 g).

Thus, there appears a need for studies of CSF pressure with increasing age, particularly at the earlier ages when the animal is adapting to its postnatal environment. Since our present CSF research with calves has been terminated, publication of these data will hopefully bring to the attention of others the possible change in CSF pressure with age in this species.

The cause(s) of the age change in CSF pressure of calves is not known. It may be related to “lumen development and fill, possibly mediated through the influence of rumen pressure on venous pressure” (1), to increasing venous pressure with increasing age (9), to possible morphological changes in arachnoid granulations and villi with increasing age of the calf (5) or to differences in response to anesthesia (5). Since venous pressure is an important factor controlling absorption of CSF (2) and thus CSF pressure, the first two factors and the fourth, insofar as it affects differences in venous pressure at various ages, need simultaneous investigation in relation to CSF pressure. In the case of possible morphological change, arachnoid granulations and villi in the very young calf appear to be functional, since the response of absorption to increased CSF pressure is essentially of the same magnitude in the very young calf as in calves approximately 5 months old (5).

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References


