Queckenstedt's test
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SUMMARY

Isovolumetric CSF pressure recording provides a very accurate analogue of hydrodynamic events occurring in the subarachnoid space. This study was undertaken to determine normal parameters of CSF pressure rise and fall on jugular compression for electromanometric CSF pressure measurement and to assess the usefulness and clinical validity of this method.

I. Queckenstedt's test - the use of bilateral jugular compression in the detection of a spinal canal obstruction - has been a useful adjunct to neurological diagnosis for more than 50 years. The simple open-end water manometer has hitherto served as the device for visualizing CSF pressure variations and it remains in clinical use, despite many attempts at technical refinement. More sophisticated manometry, especially the isovolumetric method, has contributed substantially to the understanding of the hydrodynamics of the CSF spaces.

The Monro-Kellie doctrine, viz. that the sum of the volumes of blood, CSF and brain substance within the skull is constant, is still a fundamental basis of CSF hydrodynamics. The problems of CSF secretion and absorption, dural distensibility and elasticity, and the relationship between CSF pressure and venous pressure have been greatly elucidated by the investigations of Weed, Flexner, Masserman and Bering. However, the particular hydrodynamic events occurring on jugular compression have received but scant attention: only Verjaal, Taylor and to a lesser extent Gilland advanced theories explaining the mechanism of Queckenstedt's test. One of the most valuable advances in the detection of spinal subarachnoid obstruction has been the introduction of functional manometry by Kaplan and Kennedy. By its means intermittent subarachnoid obstruction in the cervical area can be detected, and lesions of the bony cervical canal inflicting damage on the spinal cord better understood. Höök,
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III. The classical open-end manometer shows rise and fall of the
level on Queckenstedt's test within a matter of seconds. The
iso volumetric method monitors these pressure variations more faithfully: under normal circumstances a rise or fall occurs in less than
0.5 second. Cineradiological recording of the behaviour of myelo-
ographic contrast medium on jugular compression in the cervical
region confirmed this, in that very abrupt movements of the con-
trast column were demonstrated. Apparently CSF is displaced,
which is possible only if the dural sac is distensible. The properties
of the dural sac are of utmost significance in this connection. Nor-
nally it is under a certain stretch and tension. Evidence of the elasticity and distensibility of the dura was found, i.a. in the moderately damped cardiac pulsations present in the CSF, the amplitude of which diminishes on lowering of the CSF pressure. It became apparent that the logarithm of the CSF pressure was linear on withdrawal of CSF in equal volumes, as was the logarithm of CSF pressure on jugular compression; both these lines were found to run parallel. However, this linearity disappeared after withdrawal of a certain volume of fluid, indicating that the factor of dural elasticity had ceased to operate and the dura was completely relaxed. From this point it was reasoned that events in the epidural space determined the course of further diminutions in pressure.

The normal CSF pressure curve on jugular compression shows an abrupt change in the rise, the steep phase being followed by a more gradual one. This sudden transition can be explained by the role of the collateral venous circulation. Jugular compression causes an increase in the intracranial blood volume. CSF is displaced caudally and increases the volume of the dural sac. The latter becomes more distended with a consequent increase in both the CSF pressure and the venous pressure (the CSF pressure and the intradural venous pressure are identical). An appreciable increase in the venous pressure forces a collateral circulation to open up and the CSF pressure can reestablish. The significance of the epidural space lies in the presence of an extensive venous plexus which can easily compensate for changes in the volume of the dural sac.

IV. By means of quantitative analysis it could be demonstrated that the angles for the rise and fall of CSF pressure on jugular compression were fairly constant in normal subjects, and that the angle for CSF pressure fall was larger than for CSF pressure rise. The angle for CSF pressure fall appeared to be a more reliable indication of the presence of spinal subarachnoid obstruction than the angle for rise - a finding not recorded in the literature. Most obstructions were found upon performing Queckenstedt's test with the head in retroflexion. These findings indicate the importance of performing Queckenstedt's test with the head in retroflexion, and of paying close attention to the CSF pressure fall on release of jugular compression.

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compression were separately classified for the rise and the fall of
CSF pressure. Those designated as square and broken (Fig. 12) were
regarded as normal, and all the others (convex, concave, straight,
square concave, square straight and valve) as indicating obstruc-
tion of the spinal CSF pathways. Again, it was demonstrated that
the shapes upon CSF pressure fall were the most sensitive. The
authors classification of the various shapes proved helpful in the
diagnosis of obstruction, and visual evaluation of CSF pressure cur-
ves - i.e. interpreting the CSF pressure tracings without mathemati-
cal analysis - sufficed for accurate diagnosis; more detailed study
was shown to be superfluous. Following the withdrawal of 10 cm
CSF, the results of jugular compression became unreliable; more
abnormal shapes were encountered and the angles for CSF pressure
rise and fall approximated the sharper angles seen in cases of spinal
subarachnoid obstruction.

The amplitude of the cardiac pulsations is of significance in the
appraisal of the CSF pressure recordings. The well-known observa-
tion that high CSF pressures are accompanied by cardiac pulsations
of greater amplitude was confirmed by quantitative analysis. Fur-
thermore, the relationship between the height of the CSF pressure
and the pulse amplitude proved to be a linear one.

V. The clinical validity of the electromanometric method was
found to be good, and apparently contradictory results in certain
cases could be explained. However, its clinical usefulness is
limited: electromanometry proved to be of diagnostic aid only in
patients with cervical lesions, particularly in the differential diag-
nosis of intermittent obstruction (spondylotic myelopathy, pincer
mechanism, narrow spinal canal). Also, it determined the choice of
contrast medium to be used: subarachnoid obstruction - particu-
larly the intermittent variety - is thought most amenable to study
by positive-contrast myelography, because this medium permits
functional myelographic examination of the subarachnoid space.

It seemed likely that in patients with a myelopathy due to cer-
vical spondylosis (often in conjunction with a narrow spinal canal)
treated by extensive laminectomy, the operative results were better
if electromanometric examination had demonstrated a spinal sub-
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The normal CSF pressure curve on jugular compression shows an abrupt change in the rise, the steep phase being followed by a more gradual one. This sudden transition can be explained by the role of the collateral venous circulation. Jugular compression causes an increase in the intracranial blood volume. CSF is displaced caudally and increases the volume of the dural sac. The latter becomes more distended with a consequent increase in both the CSF pressure and the venous pressure (the CSF pressure and the intradural venous pressure are identical). An appreciable increase in the venous pressure forces a collateral circulation to open up and the CSF pressure can reestablish. The significance of the epidural space lies in the presence of an extensive venous plexus which can easily compensate for changes in the volume of the dural sac.

IV. By means of quantitative analysis it could be demonstrated that the angles for the rise and fall of CSF pressure on jugular compression were fairly constant in normal subjects, and that the angle for CSF pressure fall was larger than for CSF pressure rise. The angle for CSF pressure fall appeared to be a more reliable indication of the presence of spinal subarachnoid obstruction than the angle for rise - a finding not recorded in the literature. Most obstructions were found upon performing Queckenstedt's test with the head in retroflexion. These findings indicate the importance of performing Queckenstedt's test with the head in retroflexion, and of paying close attention to the CSF pressure fall on release of jugular compression.

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in the CSF, the amplitude of the CSF pressure. It became expressed if the pressure was linear on the logarithm of CSF pressure. These were found to be extrapolated after withdrawal of the factor of dural pressure. The latter was completely relaxed. The amplitude in the epidural space changed in pressure.

Jugular compression shows an increase being followed by a more rapid increase. This increase is caused by the role of the dural compression causes an increase in the epidural pressure. The latter becomes more pronounced the CSF pressure and the intradural venous pressure increase in the venous pressure, and the CSF pressure in the epidural space lies in the former can easily compensate the latter.

It could be demonstrated that pressure on jugular compression was being followed by a more rapid increase. This increase is caused by the role of the dural compression causes an increase in the epidural pressure. The latter becomes more pronounced the CSF pressure and the intradural venous pressure increase in the venous pressure, and the CSF pressure in the epidural space lies in the former can easily compensate the latter.

The amplitude of the cardiac pulsations is of significance in the appraisal of the CSF pressure recordings. The well-known observation that high CSF pressures are accompanied by cardiac pulsations of greater amplitude was confirmed by quantitative analysis. Furthermore, the relationship between the height of the CSF pressure and the pulse amplitude proved to be a linear one.

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It seemed likely that in patients with a myelopathy due to cervical spondylosis (often in conjunction with a narrow spinal canal) treated by extensive laminectomy, the operative results were better if electromanometric examination had demonstrated a spinal subarachnoid obstruction. Whether or not this observation possesses any practical value will have to be evaluated in a larger series of cases.
VI. Several other phenomena became apparent during this study of the CSF pressure curves. Respiratory fluctuations may vary, but the presence of Antoni's respiration sign of obstruction is of diagnostic significance. Changes in the cardiac rhythm should be recognized. The presence of contrast medium in the dural sac may lead to erroneous interpretations.

VII. Attention was paid to the effect of Valsalva's manoeuvre, i.e. straining, on the CSF pressure. In an appreciable number of instances a secondary pressure wave was observed following cessation of straining; its form proved to be fairly constant. The phenomenon of the secondary pressure wave could be related to the variations in cardiac minute volume. The occurrence of this secondary pressure wave was not confined to Valsalva's manoeuvre, it was also observed in certain individuals following jugular compression as a consequence of triggering a carotid sinus reflex.