

Is Flow Rate or Stroke Volume better for the assessment of CSF flow in NPH?

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Introduction: For quite some time now, two parameters have been used in the assessment of abnormality in the flow of CSF at the Aqueduct for NPH (normal pressure hydrocephalus): Stroke Volume (abnormality above 42 microliters)¹ and Flow rate (abnormality above 18 ml/min)², however this can lead to contradictory results. Both parameters can be easily calculated from the same original data, and it is important to decided which of them would be the best to be used in NPH diagnosis. For that we analyzed the data from our total group of patients and performed a study of the variation of both values with heart rate on a group of volunteers.

Subjects and Methods: Images were obtained on a 1.5T GE Signa using a Cine Vascular 2D PC sequence with an S/I flow direction (VENC=15 cm/s, Flip Angle=20°, TE=7.9 ms, TR= 40.0 ms, BW=16.0 Hz, 1 NEX, Sl.Th.=5.0 mm, FOV=24 ×18 cm and a 512x512 matrix) and post- processed with a GE Flow software. Data was acquired with peripheral Cardiac Gating (32 cardiac phases / cycle) and obtained on one oblique axial localization perpendicular to the mid section of the Aqueduct, and for the volunteers also on an axial plane intersecting the posterior arch of the atlas at the skull base, to avoid turbulence of CSF flow in the cisterna magna.

So far we have measured CSF flow in 580 patients, acquiring both Stroke Volume and Flow Rate at the Aqueduct. However for this study we only considered 421 older patients which had a suspicion of NPH and non zero flow. For our 7 healthy volunteers we measured Stroke Volume (SV) and Flow Rate (FR) at the Aqueduct (AS) and at the skull base (SB) as a function of the heart rate (HR) .

For the volunteers, we first acquired a Cine sequence at rest HR, then asked the person to run for ten minutes to increase HR, returning to the machine to obtain three extra sequences as HR lowered.

Results: Analyzing our 421 cases from our database we found that 38% were considered normal by both criteria , 1 in Fig. 1 (SV below 42 microliters and FR below 18 ml/min), 44 % were considered normal by the FR criteria and abnormal by the SV criteria, 2 in Fig. 1 (SV above 42 microliters and FR below 18 ml/min). and 18 % were considered abnormal by both criteria, 3 in Fig.1 (SV above 42 microliters and FR above 18 ml/min).

Analyzing variation with heat rate we found out that FR never decreases below 38% of the original values as the heart rate increases, clearly not changing as much as SV, which can decrease to as low as 22% of the original values for the same increase in heart rate. (Fig. 2)

Conclusion: From our results we can see that there is a very large proportion of abnormal cases (44%) according to the SV criteria and normal according to the FR criteria while we know that clinically NPH is not so common. We also observed that SV is more sensitive to cardiac rate changes than FR. Both these results lead us to believe that FR is a better parameter to evaluate NPH, being more in line with clinical data and less prone to heart rate fluctuations.

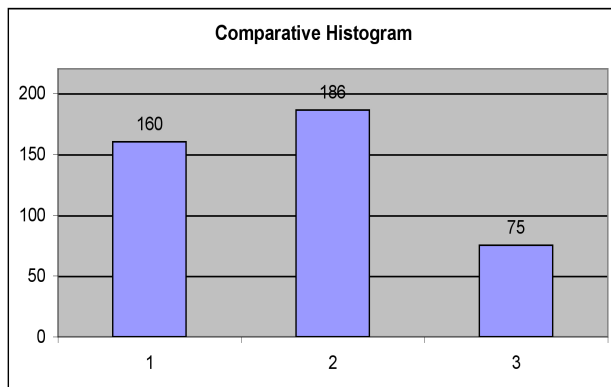


Figure 1

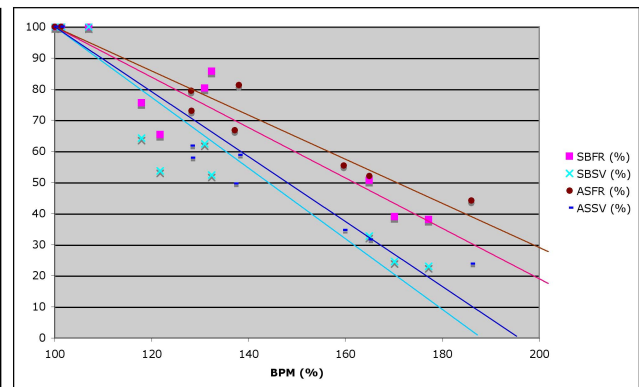


Figure 2

Figure 1 - Comparative histogram of the groups

Figure 2 - Graphs of percentage variations of FR and SV in terms of percentage BPM for the Aqueduct (AS) and the Skull base (SB).

References

1. Nitz WR, et al. Radiology [1992] 183:395-405.
2. Luetmer PH, et al. Neurosurgery [2002] 50(30):534-543.