

# Perforation holes in ventricular catheters—*is less more?*

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## Abstract

**Objective** Obstruction is a common cause of cerebrospinal fluid (CSF) shunt failure. Risk factors for proximal obstructive malfunction are suboptimal ventricular catheter positioning and slit-like ventricles. A new ventricular catheter design to decrease risk of obstruction was evaluated.

**Methods** A review of histopathological tissue investigation from occluded ventricular catheters ( $n=70$ ) was performed. A new ventricular catheter design was realized with six perforation holes. These catheters were compared to regular catheters (16 holes, Miethke, Aesculap) for flow characteristics using ink studies and flow velocity at hydrostatic pressure levels from 14 to 2 cmH<sub>2</sub>O in an experimental setup. The six-hole catheters were implanted in hydrocephalic patients with slit-like ventricles ( $n=55$ ). A follow-up was performed to evaluate the need of catheter revisions.

**Results** Histological evaluation showed that obstructive tissue involved 43–60% extraventricular tissue, including gliosis, connective and inflammatory cells. In flow characteristic studies, the 16-hole catheters showed that only proximal perforations are of functional relevance. For six-hole catheters, all perforations were shown to be relevant with remaining reserve capacity. Flow velocity however showed no significant differences between six and 16 perforations. The six-hole catheter was implanted in 55 patients with a mean follow-up period of  $15\pm 9$  months. A total of 12 catheters were explanted, revealing an overall survival proportion of 77.4%.

**Conclusion** In narrow ventricles, we assume that catheter perforations that are located also in the tissue might be a risk for CSF shunt obstruction. Fewer amounts of perforations in the catheters with equal flow features might decrease this risk when catheters can be implanted with adequate precision.

**Keywords** Hydrocephalus · Shunt dysfunction · Slit ventricle · Obstruction · Catheter

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