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Imaging in idiopathic Normal Pressure Hydrocephalus

The value of structured radiological evaluation

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Akademisk avhandling

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Abstract
Background: Idiopathic normal pressure hydrocephalus (iNPH) is a neurological condition where the symptoms include disturbed gait, balance, cognition and continence. The diagnostic guidelines are based on typical symptoms combined with imaging showing enlarged ventricles. Several scales for evaluating symptoms exist, but no corresponding tool is in use for imaging. The aim of this thesis was to construct a radiological scoring system, the iNPH Radscale, to facilitate radiological evaluation and systematic reporting of changes. Further, to test the reliability and accuracy of the scale and evaluate the usefulness for longitudinal monitoring.

Methods: In paper I 168 individuals over 65 years of age from the general population underwent computed tomography (CT) of the brain and a neurological examination, and the same cohort was followed up 2 years later in paper IV. The iNPH Radscale was developed in these papers and further validated in papers II and III. Papers II and III included surgically treated iNPH patients with preoperative imaging of the brain. Thirty-five patients were included in paper II comparing preoperative CT and magnetic resonance imaging (MRI) using the iNPH Radscale. Paper III included 75 shunt responsive patients and 55 asymptomatic controls to evaluate the accuracy of the iNPH Radscale.

Results: In paper I, seven parameters summarized as a total iNPH Radscale score were significantly associated with clinical iNPH symptoms ($r = 0.55$, $p < 0.001$). In paper II, the agreement between CT and MRI was substantial to almost perfect (kappa and intraclass correlation, 0.60–0.91, $p < 0.001$) for all parameters except periventricular white matter changes. In paper III the iNPH Radscale score was significantly higher in the iNPH group than the control group ($p < 0.001$). Receiver operating characteristics analysis yielded an area under the curve of 99.7 %, and an iNPH Radscale score ≤ 4 identified those without iNPH (sensitivity 100 %, specificity 96 % and overall accuracy 98.5 %). In paper IV, symptomatic participants had significantly higher iNPH Radscale scores at baseline and follow-up.

Conclusions: The iNPH Radscale summarizes seven imaging features from the diagnostic guidelines and is applicable to both CT and MRI. INPH is very likely in patients with an iNPH Radscale score ≥ 8 and corresponding clinical symptoms. On the other hand, the diagnosis should be questioned when the iNPH Radscale score is less than the cut-off of 4. In summary, the iNPH Radscale may become a relevant diagnostic tool for standardized evaluation in the workup of patients with suspected iNPH, as a diagnostic checklist and as a screening tool for detection with the potential for ruling out the disease.

Keywords
Hydrocephalus, normal pressure; Diagnostic imaging; Gait disorder, neurologic; Dementia; Urinary incontinence; Epidemiologic research design

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