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Large head circumference (HC) combined with accelerated HC growth rate facilitates early diagnosis of hydrocephaly

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Background

Hydrocephaly is a life-threatening condition, which needs to be diagnosed at an early stage to ensure normal neurological development (1,2). In children under 2 years, before fusion of the cranial sutures, hydrocephaly can be suspected by accelerated growth rate of head circumference (HC) before other symptoms, even before development of macrocephaly (HC > 2.0 SDS). However, the screening for hydrocephaly based on HC growth has been insufficiently explored.

Objective and hypotheses

To validate a new screening method for accelerated HC growth in children under 2 years.
We hypothesized that screening for accelerated HC growth would improve sensitivity of screening for hydrocephaly and facilitate its early diagnosis.

Subjects and methods

The screening method for accelerated HC growth was based on mathematical modelling of HC growth in a population of 15,174 healthy children (7399 girls, 7775 boys) aged 0-2 years. Growth data and medical records of 72 (28 girls, 44 boys) full term children aged 0-2 years with operated hydrocephalus were collected from three University Hospitals. The study material comprised 395 HC measurements, 2 to 18 measurements per child (median 5) before the shunt operation. The patients had been shunted at the median age of 0.29 years (range 0.01 to 1.88 years). HC measurements were converted into standard deviation scores (SDS), and HC SDS changes between each HC measurement and all the subsequent HC measurements of each child were converted into standardized HC SDS change values derived from the mathematical model.The diagnostic accuracies of HC SDS change ("accelerated HC growth"), HC SDS, and their combination for hydrocephaly were calculated using receiver operating characteristic (ROC) analysis. The sensitivity was assessed at the specificity level corresponding the HC cutoff 2.0 SDS if HC SDS was used as a screening criterion, which is the common treshold of macrocephaly. The specificity was 94.1%, and the same cutoff level was used in calculating the median ages for the first pathological values in each model.

Patient characteristics

Gender	n/72 (%)
Girls	28 (38.9%)
Boys	44 (61.1%)
Etiology of hydrocephalus	**n/72 (%)**
Intracranial hemorrhage	18 (25.0%)
Arachnoid cysts	11 (15.3%)
Aqueductal stenosis	7 (9.7%)
Dandy-Walker syndrome	7 (9.7%)
Other cerebral anomaly	3 (4.2%)
Myelomeningocele	7 (9.7%)
Infection	3 (4.2%)
Tumours	2 (2.8%)
Hydrocephalus NAS	14 (19.4%)

Table 1. Characteristics of 72 patients aged 0-2 years with shunted hydrocephalus

Results

In the ROC analysis the accelerated HC growth alone (AUC 0.89) and its combination with plain HC SDS gave almost the same result (AUC 0.88), whereas plain HC SDS had lower accuracy (AUC 0.82). The median age at the first pathologic value was 0.17 y if accelerated HC growth was used as a screening criterion, in comparison to 0.30 y if HC SDS > 2SD was used as screening criterion (Table 2).

The combined (69.4%) and the accelerated HC growth criteria (66.7%) had nearly the same sensitivities whereas the HC SDS model had lower sensitivity (58.3%).

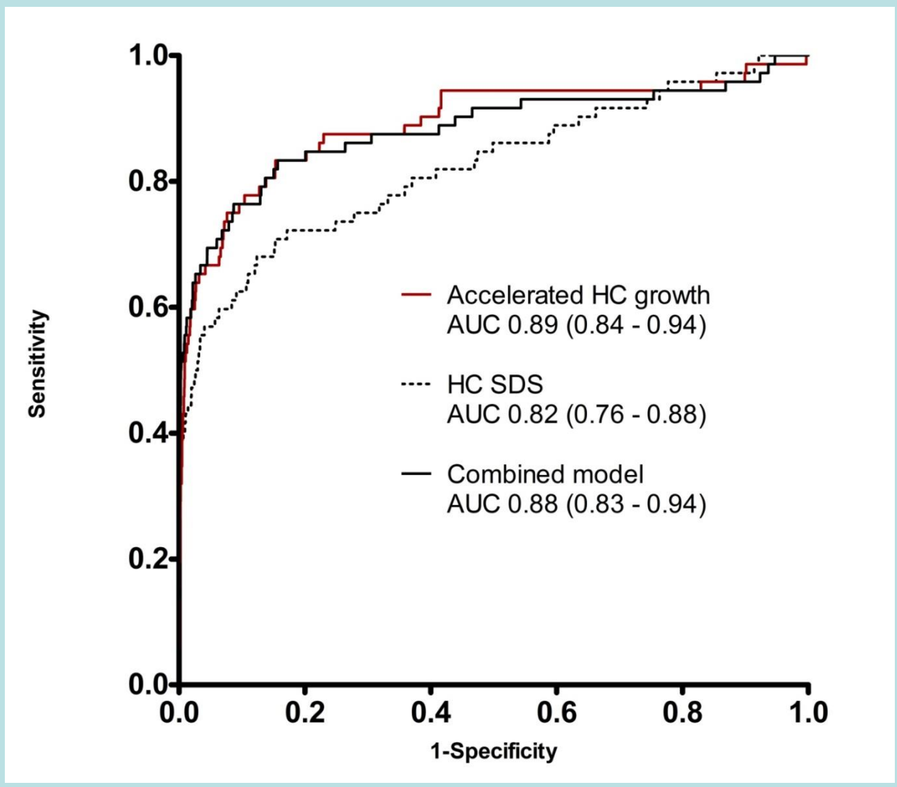

Figure 1.ROC curves and screening accuracies (AUC) for three head circumference (HC) based screening methods of hydrocephaly in 72 children aged 0-2 years with postnatal hydrocephaly requiring shunt operation.

Table 2. Comparison of three head circumference (HC) based screening methods of hydrocephaly in terms of the median age for the first pathological value and the sensitivities in 72 children aged 0-2 with postnatal hydrocephaly requiring shunt operation.

Screening method	Median age (years) for the first pathological value	Sensitivities at specificity level 94.1%
HC SDS	0.30	58.3%
Accelerated HC growth	0.17	66.7%
Combined method	0.20	69.4%

Conclusions

Detection of hydrocephaly in children under 2 years is improved if screening criteria include HC growth rate in addition to plain HC.

References

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