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PREDICTING 'DANGEROUS' BLADDERS IN CHILDREN: PROBLEMS IN USING AREA UNDER THE CURVE (AUC)

Hypothesis / aims of study

A principal indication for video urodynamics (VUDS) in children is to distinguish between a 'safe' bladder (one that is not causing any problems and should not cause any later on) and a 'dangerous' bladder (one that is causing current problems or may cause problems in the future, particularly with respect to upper tract function).

Current practice includes looking at compliance ($\Delta V/\Delta P$) to predict the presence of 'dangerous' bladders and to note whether or not vesico-ureteric reflux (VUR) is present. Compliance is calculated from the start and end of filling vesical pressure. This does not take into account children where the presence of multiple high-pressure detrusor overactivity (DO) waves may cause upper urinary tract damage although compliance may be within normal limits. There are no standard methods of measurement and thus no 'cut-off' values to differentiate between 'dangerous' and 'safe' bladders.

Previous studies have shown that persistent pressures over 40cm H_2O lead to upper urinary tract dilatation and that 95% of normal children hold urine in the bladder at low pressures (<20cm H_20), 95% of the time. It has also been suggested that spending more than 5% of the filling phase with pressures over 20cm H_20 is abnormal and dangerous (1).

Methods of measuring the AUC in mathematics include using a planimeter, which is a mechanical integrator that consists of a bar, a measuring wheel and a constraint mechanism that restricts the movement of one end of the bar. Another method is cutting out the waves on a curve and measuring their mass. The mass will be proportional to the area. Both these methods are not practical in daily clinical practice.

In view of the above limitations, the aim was to assess an alternative method of measuring the area under the detrusor pressure (p_{det}) curve during filling, with the aid of computer software, which could be used as a useful parameter in predicting 'dangerous' bladders (2,3).

Study design, materials and methods

130 children had VUDS between October 2000 and February 2004. Direct transfer of raw data to the database was only possible in 33 cases. This resulted in only 15 analysable traces; 12 males and 3 females with a median age of 2 years (range 6 months to 15 years).

The traces were analysed manually to check for quality control and baseline p_{det}. Computer software was used to integrate the area under curve of p_{det} versus volume infused. The integral divided by bladder capacity gave the mean pressure change in cmH_2O.

Results

Small bladders with a capacity that was less than expected using the formula (30+(30xage in yrs)mls) seem to have higher pressures. 6 out of 15 patients had small bladders when compared to expected bladder capacity. 6 patients had VUR and 12 had DO. No correlation could be established between the area under the curve and the possibility of predicting 'dangerous' bladders. Interestingly, the average height of DO waves appeared to correlate with predicting 'dangerous' bladders.

5 out of 6 patients with VUR had average height of waves ≥20 cmH_20. 4 patients had pressures less than 20 and they had normal bladders with no DO. The remaining 5 had high pressure DO.

Interpretation of results

Limitations in the UDS machine and computer software excluded 115 patients. The software could also not exclude artefacts that could have affected the calculated mean pressure e.g. causing negative mean pressures. This was apparent when comparing the result from the AUC to the average calculated pressure by manually measuring the average height of the DO waves.

Other factors that could have contributed to poor correlation is that some patients already had VUR. This may act as a protective measure for the bladder by helping to reduce the intravesical pressure and thus is likely to be reflected in reduced calculated pressures.

Leakage also occurred in some patients: the software does not recognise this and therefore an error is introduced in the measurement.
The concept of measuring the average height of the waves is somewhat similar to the concept of detrusor overactivity index (DOI = sum of the height of all the waves/bladder capacity during filing) used to describe the severity of DO. However there are no standardised values for DOI.

Concluding message

There is great need for guidelines to help diagnose 'dangerous' bladders in children. The area under the curve could be a potential predictive indicator in determining the overall change in pressure in the bladder during filling. Its usefulness as a tool to predict 'dangerous' bladders needs to be established by multi-centre trials and with the use of new software and equipment. The 1997 ICS report proposed an ICS standard for digital exchange of pressure-flow study data which is based on MS-DOS and probably needs updating however it should form the basis for conducting these large trials with new software. The average height of DO waves emerged from this study as a simple potential tool in predicting 'dangerous' bladders especially when p_{det} is greater than 20 cm H_20. Ours has been a failed study that has emphasised the need for ICS definitions and recommendations in the area of bladder compliance and paediatric studies.

References

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