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Serial Pupillometer Readings Predicting Intracranial Pressure Crisis In Neurocritical-Care Patients

Antje Giede-Jeppe, Julia Koehn, Stefan T. Gerner, Joji B. Kuramatsu, Hagen B. Huttner, Stefan Schwab

Department of Neurology, University Hospital, Erlangen, Germany

Introduction

Elevated intracranial pressure (ICP) and cerebral edema are common causes of mortality in neurocritical-care patients. Key monitoring techniques for ICP-elevation include neuroimaging and invasive ICP-measurement. Examination of the pupils is routinely performed to determine disturbances within cerebral physiology but shows high inter-rater variability. Portable infrared pupillometry is increasingly used for accurate measurements. The benefit of these technique remains to be established in patients with elevated ICP. Aim of this study was identify pupillary parameters associated with ICP-crisis in neurocritical-care patients.

Methods

We prospectively enrolled 31 critically-ill patients (subarachnoid hemorrhage/intracerebral hemorrhage/stroke/bacterial meningitis) admitted to our neurointensive care unit(07/2016-07/2017) who required placement of external ventricular drains. We recorded serial pupillometer readings [i.e. maximum/minimum apertures(mm), constriction/dilation velocities(mm/sec.), latency period(sec.)] and corresponding ICP values every 3 hours after admission. Neurological Pupil index(NPi), an algorithm that compares above mentioned pupillary parameters to a normative model of pupil reaction to light, grades pupil-function on a scale of 0(nonreactive) to 5(normal). Receiver Operating Characteristic(ROC) Curve Analysis was performed to investigate associations between pupillary parameters and presence of ICP-crisis(ICP>20mmHg).

Results

In 31 patients (median age:58(49-69)years) 1900 serial pupillary assessments were available for analysis. Median pupillometer readings of enrolled patients included maximum pupil size[Right(R)2.28(2.06-2.6)/Left(L)2.36(2.14-2.63)], NPi[R4.4(4.0-4.6)/L4.3(4.0-4.6)], latency[R0.23(0.23-0.27)/L0.23(0.23-0.27)], dilation velocity[R0.32(0.19-0.45)/L0.30(0.19-0.42)], median constriction velocity[R1.32(0.90-1.70)/L1.26(0.90-1.64)], constriction velocity[R0.89(0.58-1.17)/L0.88(0.59-1.14)] and minimum pupil size[R1.99(1.75-2.24)/L2.05(1.85-2.27)]. In 9 of 31 patients 79 ICP-crisis were detected. Graphical regression analysis(ROC) revealed a negative association between NPi, MCV and CV and detection of ICP-crisis. In our cohort strongest association with presence of ICP-crisis was found in NPi(R)(area under the curve[AUC]0.229) followed by MCV(R)(AUC0.241), CV(R)(AUC0.243), CVL(AUC0.263), MCVL(AUC0.270) and NPi(L)(AUC0.273,p4.15 [NPi4.15:16/1225(1.3%);OR(95%CI):7,74(4.43-13.51);p<0.001].

Conclusions

Our data suggest a relationship between non-invasively detected changes in NPi, CV or MCV and ICP-crisis. Yet, clinical benefit of these parameters is subject to future studies.