Diagnostic Accuracy of Intraocular Pressure Measurement for Detection of Raised Intracranial Pressure: A Systematic Review and Meta-Analysis

Daniel Yavin MD; Judy Luu BSc, PhD; Nathalie Jette; Samuel Wiebe MD, MSc
Department of Clinical Neurosciences,
Department of Community Health Sciences,

Introduction: As clinical examination and imaging may be unreliable indicators of intracranial hypertension (IC-HTN), intraocular pressure (IOP) measurement has been proposed as a non-invasive method of diagnosis. We therefore conducted a systematic review and meta-analysis to determine the correlation between IOP and intracranial pressure (ICP) and the diagnostic accuracy of IOP measurement for detection of IC-HTN.

Methods: We searched bibliographic databases (Ovid MEDLINE, Ovid EMBASE, and the Cochrane Central Register of Controlled Trials) from 1950-March 2013; references of included studies; and conference abstracts for studies comparing IOP and invasive ICP measurement. Two independent reviewers screened abstracts, reviewed full text articles and extracted data. Correlation coefficients, sensitivity, specificity, and positive and negative likelihood ratios were calculated using DerSimonian and Laird methods and bivariate random effects models. The I2 statistic was used as a measure of heterogeneity.

Table 1. Characteristics of studies included studies.

Study (Year)	Country	*N*	Age (yrs)	Setting	IOP (mm Hg)	ICP (mm Hg)	Assessment of ICP	IC-HTN Prevalence	Timing of ICP & IOP Measurement
Blank, *et al.* (1988)	Germany	8	68	ICU	15.1	9.9	ICP Monitor	39%	> 1 hour delay
Czarnik, *et al.* (2009)	Poland	40	54	ICU	14.2	28.3	ICP Monitor	NR	Simultaneously
Han, *et al.* (2008)	USA	55	48	Clinic	14.4	14.1	LP	NR	> 1 hour delay
Kirk, *et al.* (2011)	USA	45	45	Clinic	13.9	18.3	LP	NR	> 1 hour delay
Lashutka, *et al.* (2004)	USA	27	60	ICU	NR	NR	EVD/ICP Monitor	68%	Simultaneously
Li, *et al.* (2012)	China	130	37	Clinic	14.4	12.8	LP	29%	< 1 hour delay
Morgan, *et al.* (2012)	Australia	9	39	ICU	15.1	4.4	EVD/ICP Monitor	0%	Simultaneously
Muchnok, *et al.* (2012)	USA	32	41	ED	NR	NR	LP	NR	< 1 hour delay
Ren, *et al.* (2011)	China	71	46	Clinic	14.3	12.9	LP	0%	< 1 hour delay
Sajjadi, *et al.* (2006)	Iran	50	34	Clinic	20.4	19.1	LP	54%	< 1 hour delay
Sheeran, *et al.* (2000)	UK	31	NR	ICU	NR	NR	EVD/ICP Monitor	NR	Simultaneously
Spentzas, *et al.* (2010)	USA	36	5	ICU	NR	NR	ICP Monitor	34%	Simultaneously

Results: Among 355 identified citations; 12 studies enrolling 546 patients were included in the meta-analysis. The pooled correlation coefficient between IOP and ICP was 0.44 (95% CI, 0.26 to 0.63; I2 statistic, 97.7%, p < 0.001). The summary sensitivity and specificity for IOP for diagnosing IC-HTN were 81% (95% CI 26 to 98; I2 statistic, 95.2%, p < 0.01) and 95% (95% CI 43 to 100; I2 statistic, 97.7%, p < 0.01), respectively. The summary positive and negative likelihood ratios were 14.8 (95% CI 0.5 to 417.7) and 0.2 (95% CI 0.02 to 1.7), respectively. When ICP and IOP measurements were taken within an hour of another, correlation between the measures improved.

Figure 1. Correlation between IOP and ICP

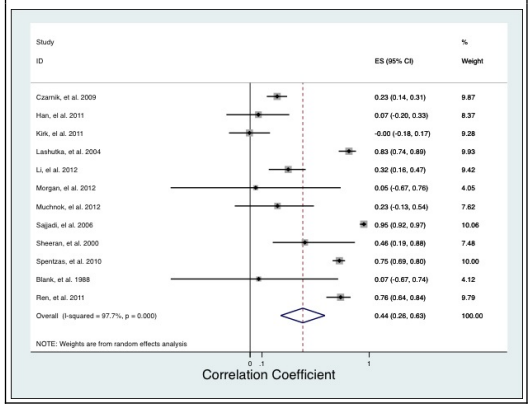

Figure 2. Hierarchical summary receiver operating characteristics.

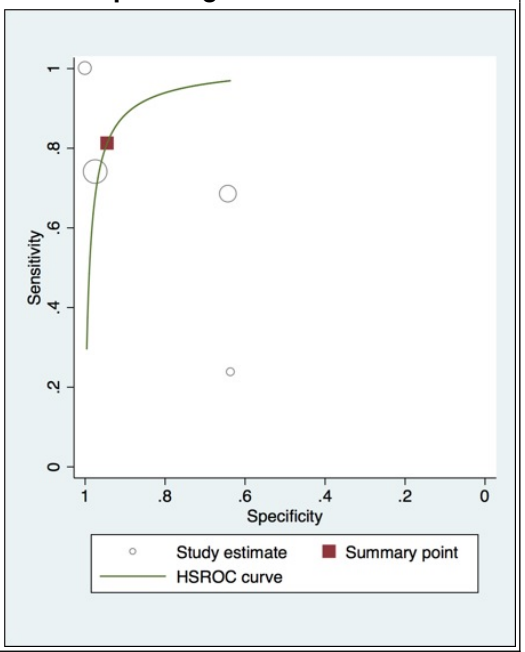

Table 2. Meta-regression: Estimated influence of study characteristics.

Study Characteristic	Correlation Coefficient (95% CI)	I^2	*p* - Value§
Quality*			
< 9	0.47 (0.24 to 0.70)	92%	0.95
≥ 9	0.42 (0.12 to 0.73)	98%	
Method of ICP Measurement			
LP	0.44 (0.26 to 0.63)	98%	0.77
ICP Monitor	0.49 (0.23 to 0.75)	96%	
Timing of IOP and ICP Measurement			
< 1 hour	0.56 (0.38 to 0.75)	98%	<0.03
> 1 hour	0.02 (-0.12 to 0.16)	0%	

Conclusions

Although a modest aggregate correlation was found between IOP and ICP, the pooled diagnostic accuracy suggests IOP measurement is of clinical utility in the detection of IC-HTN. Given the significant heterogeneity between included studies further investigation is required prior to the adoption of IOP in the evaluation of IC-HTN into routine practice.

Figure 3. Pre- and posttest probabilities of IC-HTN.