



# NON-INVASIVE ESTIMATION OF INTRACRANIAL HYPERTENSION: A MULTIMODAL APPROACH

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## BACKGROUND

Elevated intracranial pressure (ICP) is a well-known cause of secondary brain injury. The gold standard method of measuring ICP is using an intra-cerebral catheter, but several non-invasive techniques can be used to estimate it, with controversial results about their accuracy

## AIM OF THE STUDY

To compare different non-invasive methods of ICP assessment.

## METHODS

This prospective, observational study included ICU patients in whom invasive ICP monitoring was initiated.

- The following non-invasive methods were simultaneously used to estimate ICP:
- ✓ ocular ultrasound to measure the optic nerve sheath diameter (ONSD)
  - ✓ transcranial Doppler to measure the pulsatility index (PI) and the estimated ICP (eICP) according to standard formulas (*Rasulo et al. Critical Care 2017; 21(1):44*)
  - ✓ Automated pupillometry (NeuroOptics, Irvine, USA) to measure the neurological pupil index (NPI).

The mean value from both eyes was calculated for all measurements and correlations assessed using a Pearson’s or Spearman’s test, as appropriate.

## RESULTS

We studied 100 patients (traumatic brain injury = 30, subarachnoid hemorrhage = 47; others =23) with a median age of 52 [44-62] years. Median Glasgow Coma Scale score on admission was 8 [5-12] and ICP assessment was performed 2 [2-3] days after ICU admission. Median ICP values were 17 [12-25] mmHg and was > 20 mmHg (i.e. elevated ICP) in 37 patients. There was a significant correlation between all the different techniques and ICP (Figure 1); median values for all non-invasive methods were significantly higher in patients with elevated ICP when compared to others. The area under the curve to predict elevated ICP (i.e. > 20 mmHg) was higher for eICP and PI than for other methods (Figure 2).

Table 1. Main characteristics of studied population

	ALL (n=100)	TBI (n=30)	SAH (n=47)	OTHERS (n=23)
Age, years	52 (44-62)	48 (31-62) <sup>b,c</sup>	53 (46-59)	55 (44-65)
GCS on Admission	8 (5-11)	7 (4-10)	9 (5-13)	9 (7-13)
Vasopressors, n(%)	60 (60)	22 (73)	33 (70)	5 (22) <sup>a,b</sup>
Opioids, n(%)	55 (55)	21 (70) <sup>b,c</sup>	24 (51)	10 (43)
Barbiturates, n(%)	7 (7)	3 (10)	3 (6)	1 (4)
GCS on ICP assessment	7 (3-10)	6 (3-8)	7 (3-11)	9 (3-12)
ICP, mmHg	17 (12-25)	20 (13-26)	14 (12-23)	15 (12-23)
Elevated ICP, n(%)	37 (37)	15 (50) <sup>b,c</sup>	15 (32)	7 (30)
CPP, mmHg	77 (68-88)	75 (67-86)	78 (70-90)	82 (66-91)
Mean ONSD, mm	5.2 (4.8-5.8)	5.2 (4.8-5.7)	5.2 (4.9-5.9)	4.8 (4.5-5.6)
Mean PI	0.93 (0.82-1.14)	1.01 (0.90-1.15)	0.88 (0.80-1.08)	0.91 (0.83-1.12)
eICP, mmHg	18 (13-24)	19 (15-24)	16 (12-21)	18 (13-24)
Mean NPI	4.2 (3.8-4.6)	4.1 (3.6-4.3)	4.2 (3.6-4.6)	4.5 (4.0-4.7)

<sup>a</sup> p<0.05 vs. TBI; <sup>b</sup> p<0.05 vs. SAH; <sup>c</sup> p<0.05 vs. Others

Figure 1. Correlation between ICP and non-invasive methods.

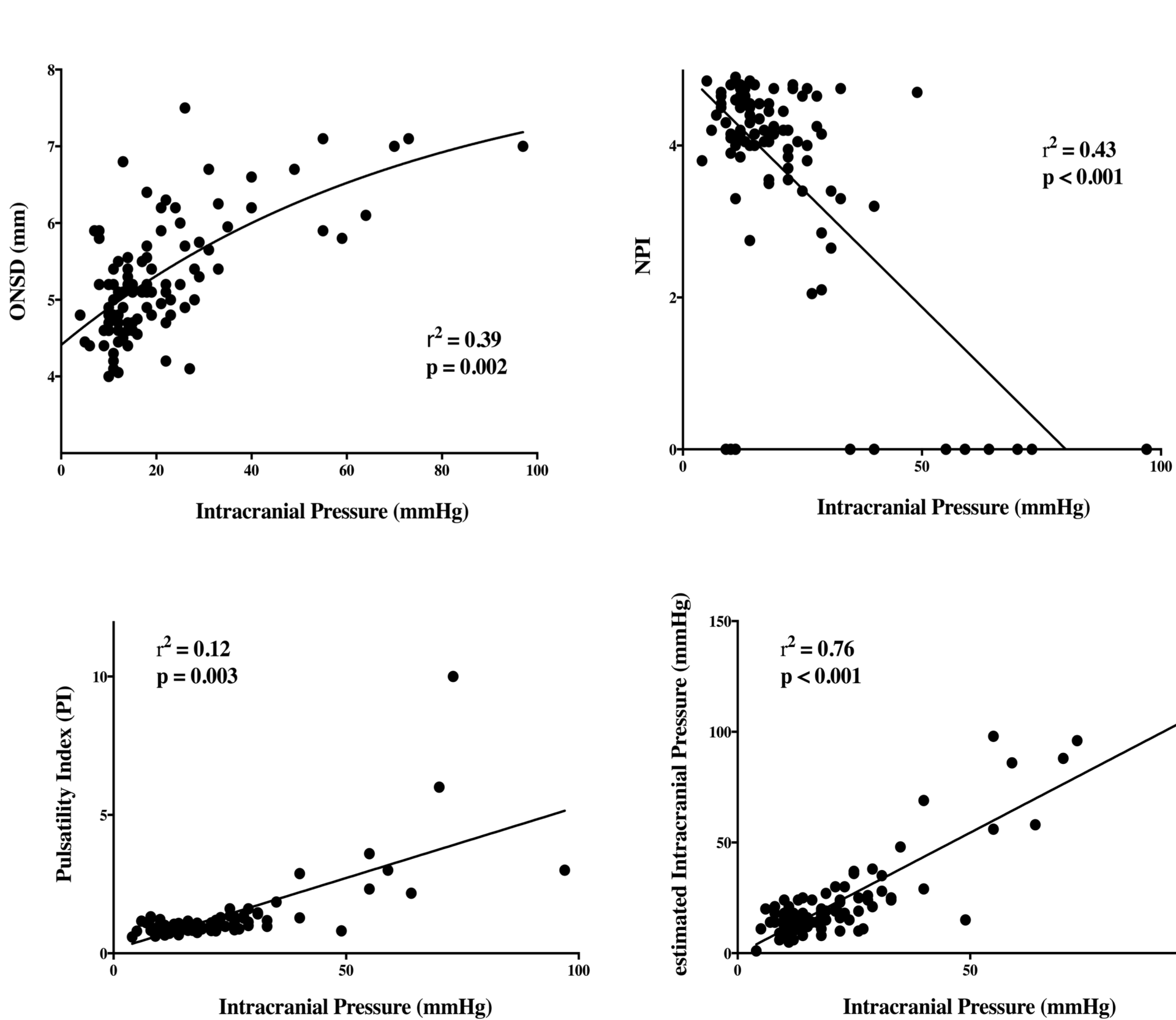
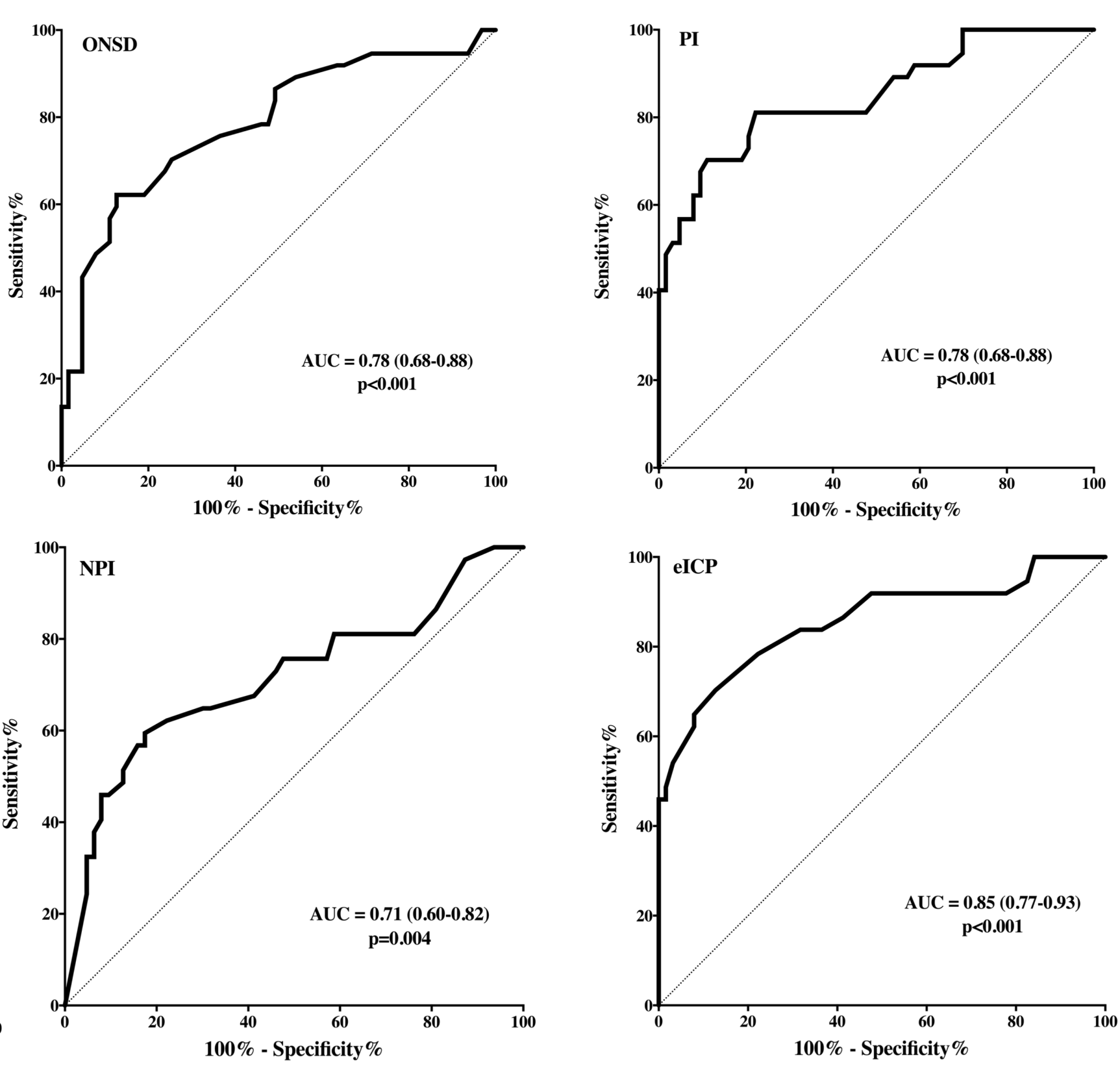


Figure 2. Predictive value of non-invasive methods for elevated ICP.



## CONCLUSIONS

Non-invasive techniques were well correlated with ICP and have an acceptable predictive value for intracranial hypertension.