Transorbital sonographic evaluation of optic nerve sheath diameter in Hong Kong Chinese patients with raised intracranial pressure

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Background:

In neurocritical care, the detection of raised intracranial pressure (ICP) is important

∵ it is associated with poor outcome

- Gold standard for continuous and reliable measurement of ICP ⟶ Invasive ventricular devices
- Drawbacks: relative contraindications in pts with blood coagulation disorder or surgical difficulties.

  Also malfunction or obstruction of ventricular catheter ~ 6%

∴ Non-invasive ocular ultrasonography has recently been proposed to detect elevated ICP.

- The optic nerve sheath is continuous with the dura mater
- CSF usually communicates freely between the intracranial space and the optic nerve
- Ultrasound of the eye is possible to determine the optic nerve sheath diameter (ONSD), which has been shown to have a linear correlation with ICP

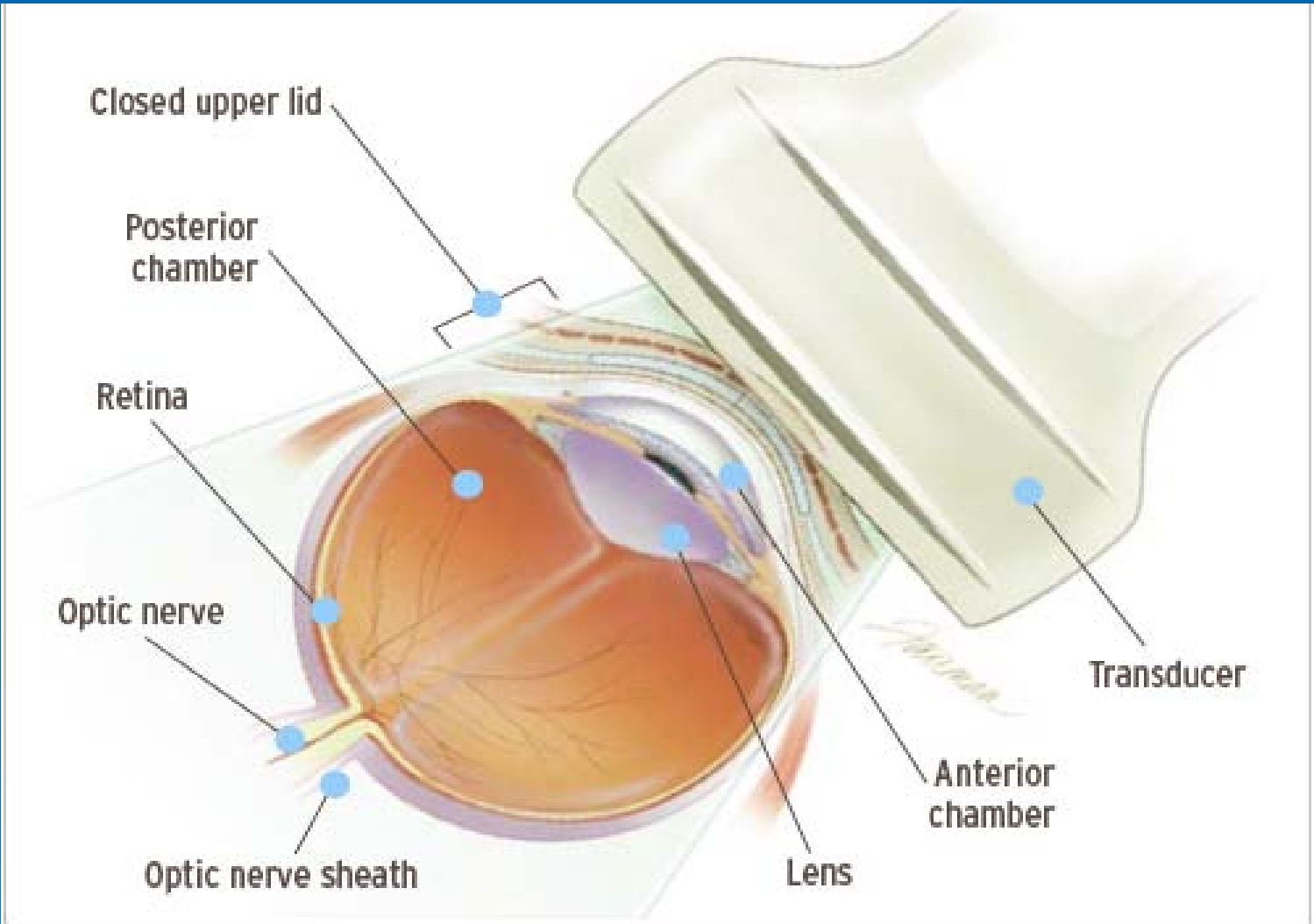

FIGURE 4. Diagram of sonographic measurement of optic nerve sheath diameter

- Objective:
  - To evaluate the use of ultrasonography of the optic nerve in patients with intracranial hypertension.
  - To verify that the optic nerve sheath diameter changes concurrently with intracranial pressure variation.
  - To assess the reproducibility of the measurement of the optic nerve sheath diameter.

- Prospective, observational study in a 26-bed multivalent intensive care unit in Hong Kong.
- From May to Aug 2009
- 17 Chinese adult patients with cerebral insult requiring invasive ICP monitoring were enrolled.
- ONSD was measured with a 7.5 MHz linear ultrasound probe.

- Exclusion criteria:
  - Age < 18 years old
  - Ocular trauma
  - A known history of ocular pathology (i.e. glaucoma or cataract)

Measurement: Median binocular ONSD was measured

ICP values were registered simultaneously

- Ultrasound examination of eye was performed by investigators trained in ocular sonography

- The learning curve (Tayal et al) seems to be quick,

  for untrained sonologists: ~ 25 scan may be needed

  for experienced sonologists: 10 patients with 3 abnormal scan may be enough

- All subjects were examined in the supine position

  Tegaderm was applied to eye to keep eyelids closed and sterile coupling gel was applied.
- ONSD was meausured 3mm behind the point where the optic nerve entered the globe.

  - horizontal and vertical diameters of the optic nerve in both eyes were measured and 2 measurements of each plane in each eye were performed.
- Data were collected on D1 or D2 after admission.

FIGURE 3. Measuring optic nerve sheath diameter using ultrasonography at the bedside

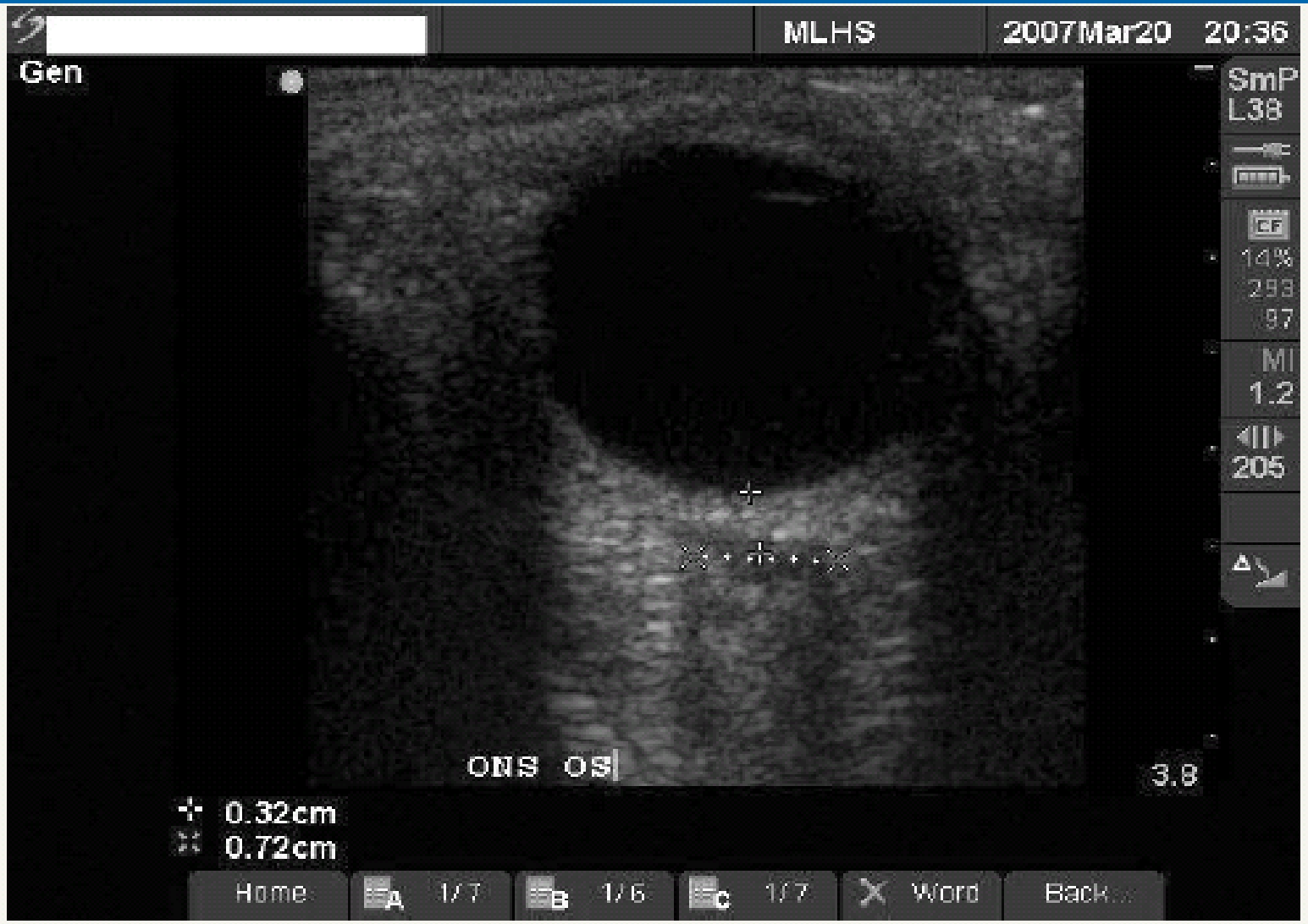

FIGURE 1. Sonographic measurement of the left optic nerve sheath is shown; the + measurement is 3 mm behind the optic disk, and the × measurement is the optic nerve sheath diameter.

17 Chinese patients with ICP monitoring were included.

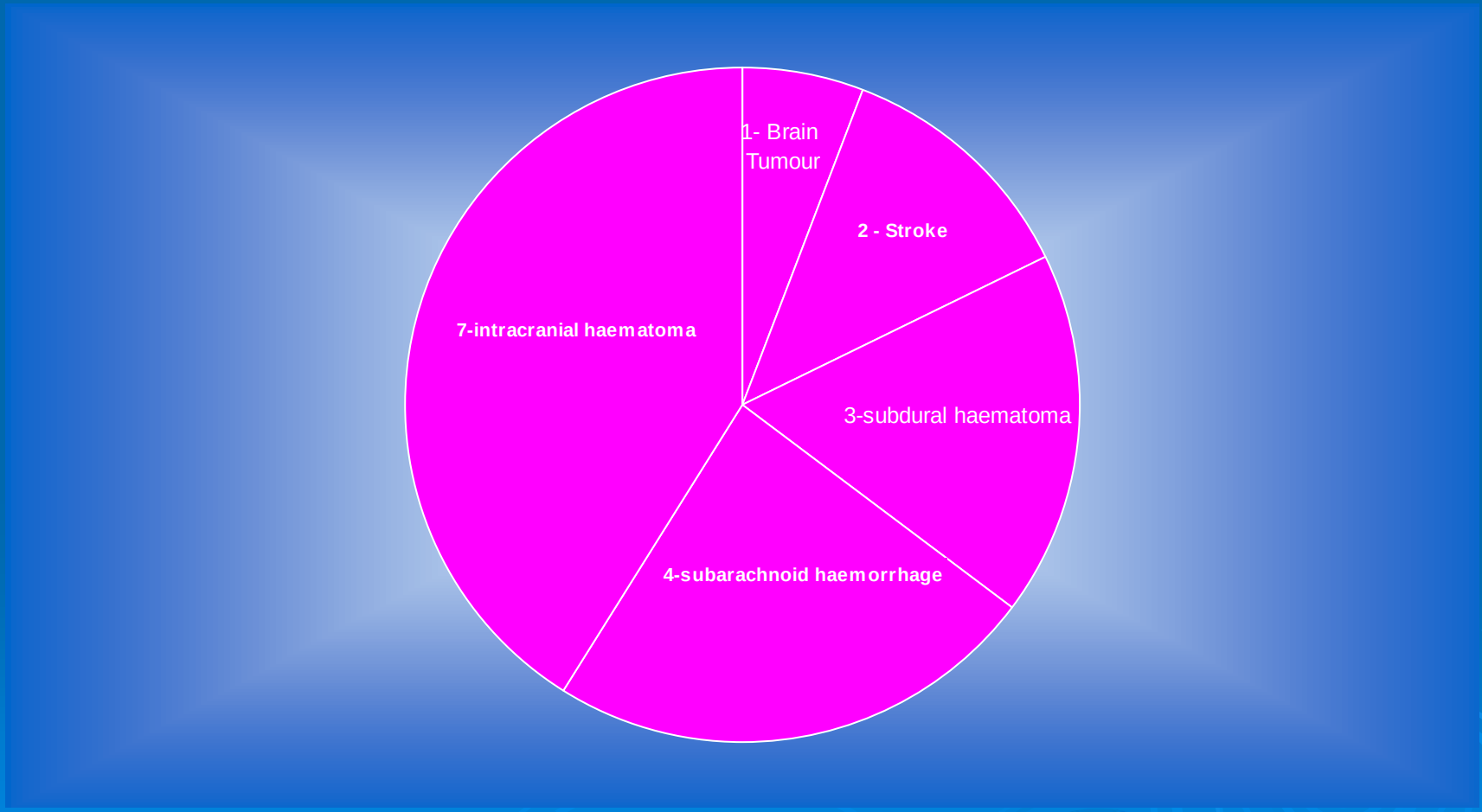

Table 1 Demographic data of patients:

	Median (+/- 25th &75th quartile)	Range
No. of patient	17	
Age (years)	58 (52&71.5)	21-79
Sex	Male -7, female - 10	
ICP (mmHg) during sonography	11(3&19)	1-45

* ICP = intracranial pressure

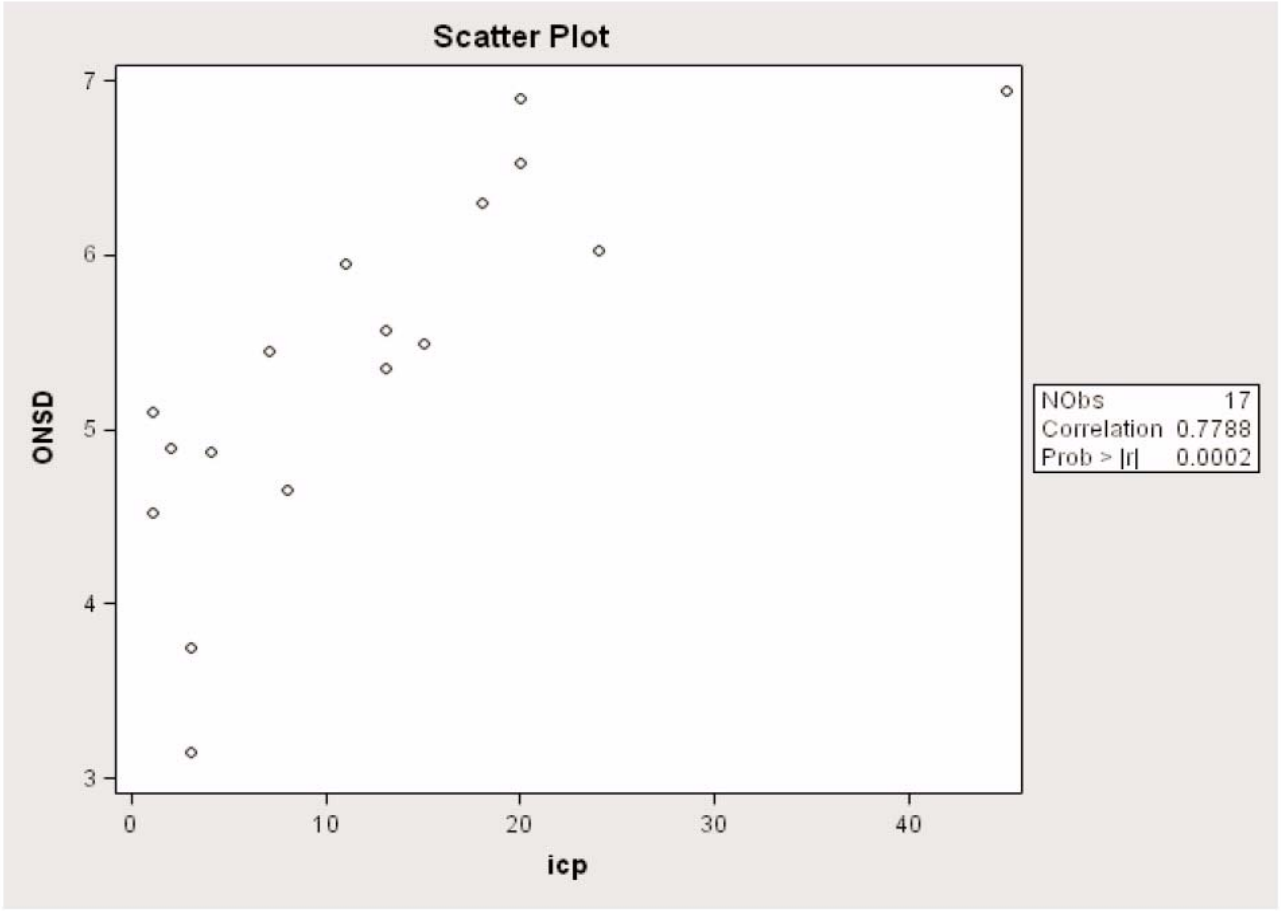

Fig 4 Scatterplot: ONSD vs ICP, r=0.78, p<0.0001, 95% CI for r=0.47-0.92

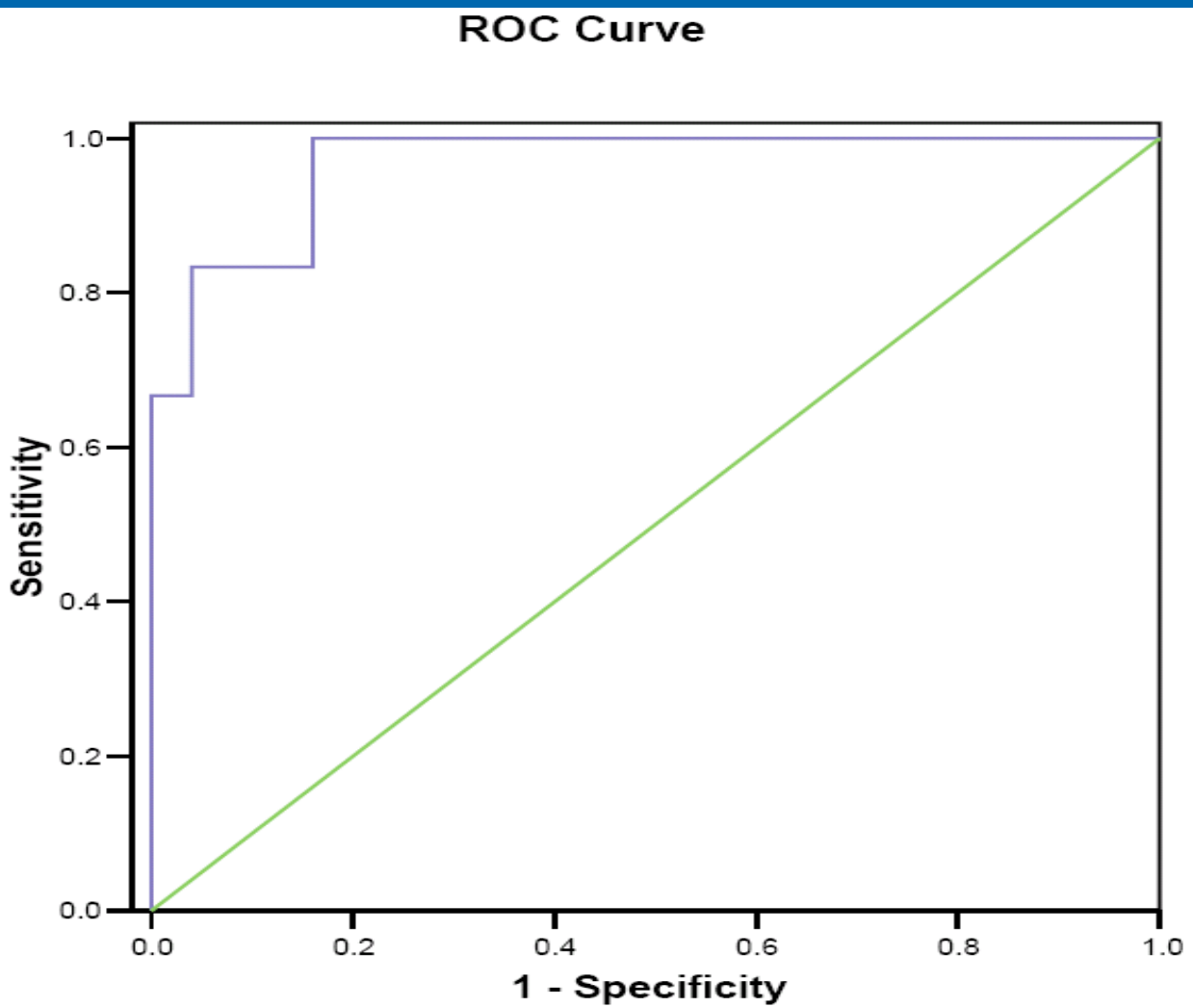

Fig. 5 ROC curve for optic nerve sheath diameter

AUC= 0.98

- The median intraobserver difference was 0.22mm (interquartile range 0.1-0.4mm)
- The median interobserver difference was 0.27mm (interquartile range 0.1-0.5mm)

- Local result vs previous result:

This study shows that ONSD – ICP correlation coefficient of 0.78 and a cut-off point of 5.99mm (sensitivity of 99% and specificity of 7.7) to predict raised ICP >20mmHg(area under ROC curve 0.98).

Kimberley et al 2008 USA	**15 patients**	**•Spearman rank correlation coefficient 0.59 (p<0.0005) •ONSD > 5mm (sensitivity 88% and specificity 93% for diagnosis of ICP > 20 cm H_2O**
Geeraerts et al 2007 France	31 patients	• spearman rank correlation coefficient 0.68 •Sensitivity and negative predictive value of optic nerve sheath diameter > 5mm detecting ICP >20 cm H_2O 100%
Karakitsos et al 2006 Greece	54 patients	•ONSD > 5.9 mm and ONSD increase of 2.5 mm in serial readings associated significantly with brain death (p<0.01)
Hanson et al 1997 Germany	54 patients	•Mean linear regression correlation of 0.78 between ONSD and CSF pressure across all subject
Goel et al 2008 India	100 patients	•ONSD > 5mm significant increase in need for neurosurgical intervention (p< 0.0001)

- Transorbital sonographic evaluation of ONSD was possible and acceptable in Hong Kong Chinese adults.
- The procedure was convenient and fast measurements of ONSD in both eyes could be finished in 5-10 min
- More convenient in measuring the ONSD vertically compared with horizontally, and also, with higher correlation with ICP.
- In this study, the measurements in horizontal plane are slightly higher than the measurement in vertical plane (may be due to frequent occurrence of artefacts when the probe is horizontal).

Conclusion:

- This study shows that ONSD measurement correlated with ICP variation.
- ONSD measurement proved to have good reproducibility
- Optic nerve ultrasound can be used as a non-invasive method to detect elevated ICP in Chinese adult patient.

Limitations of this study:

1. Sample size was small
2. Ultrasonographer was not blinded to absolute ICP value and may affect ONSD measurement.
3. Experience of the person taking the ONSD measurement by bedside ocular ultrasound machine, the quality of the device and the cooperation of the subject would also affect the reliability of the results.