



# Ultrasonography as a Safe Tool for Assessing Shunt Patency

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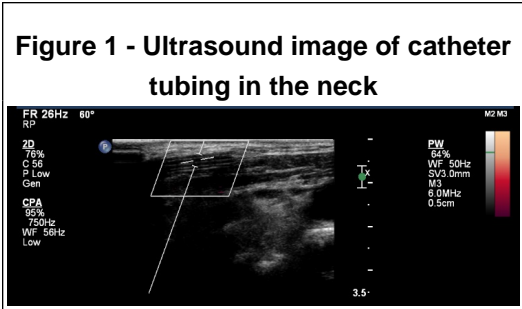


## Learning Objectives

By the conclusion of this session, participants should be able to: 1) Describe the methods for the use of ultrasound for the assessment of shunt patency 2) Assess the strengths and limitations for the use of ultrasound for the assessment of shunt patency 3) Assess the diagnostic accuracy of the ultrasound shunt patency test in comparison to the radionuclide test.

## Introduction

Ventriculoperitoneal (VP) shunts are used in the treatment in hydrocephalus, although they have a propensity to become obstructed. A radionuclide shunt patency test is the gold standard used help determine whether a shunt is blocked or not. There have been several prior studies that have investigated the use of ultrasound for the determination of shunt patency, particularly among pediatric patients. The goal of this study was to validate the use of ultrasound in the assessment of a suspected ventriculoperitoneal or ventriculoatrial shunt obstruction in adult patient.



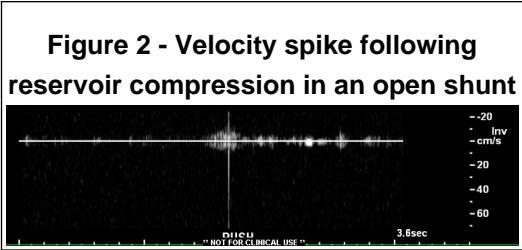
## Methods

### Experimental model

An experimental model was developed to determine whether ultrasound could visualize flow through shunt tubing. Water was flushed through the tubing by compressing a connected reservoir and ultrasound was used at the distal end of the tubing to visualize the flow when the tubing was open vs. manually obstructed.

### Cohort study

IRB approval was obtained for this study. Eighteen patients scheduled for a radionuclide shunt patency study also received an ultrasound shunt patency study after obtaining informed consent. Their shunt reservoir was pumped quickly and forcibly 3 times by an assistant while the ultrasonographer visualized shunt tubing in neck with an ultrasound probe (Figure 1). The doppler flow speed was recorded. A ROC curve was created to compare performance of test against the gold standard radionuclide shunt patency test.



## Results

In the experimental model, flow was visualized by the ultrasound machine when the tubing was open, and not visualized when the tubing was obstructed. In the clinical study, the mean age of participants was 60.4 years and 61% were male. Seven patients had a VP shunt and 11 had a VA shunt. 14 patients had a Progav shunt, 2 a Strata shunt, and 2 a Codman-Hakim shunt. Figure 2 is an example of when the shunt was determined to be open due to the presence of a sharp velocity spike upon reservoir compression, whereas figure 3 corresponds to a blocked shunt, due to the absence of a velocity spike.

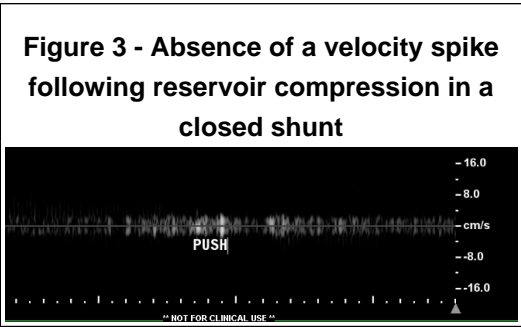
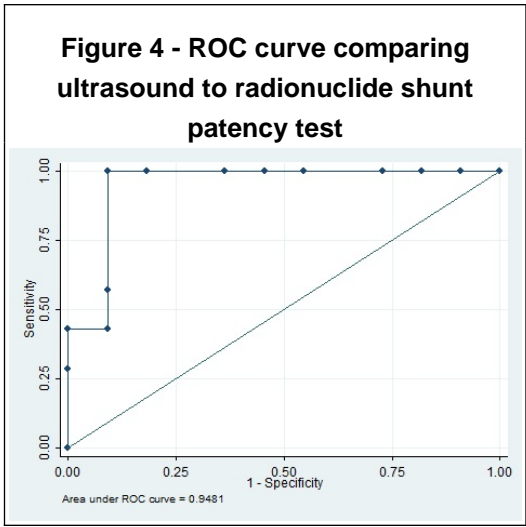


Figure 4 shows the ROC curve of the diagnostic accuracy of ultrasound test compared to the radionuclide test. The AUC was 0.9481 (95% CI: 0.84006 – 1.00000) with a SE of 0.0551 (p = 0.002). The optimum cutoff threshold for shunt patency in ultrasound flow obtained from the ROC curve was 10 cm/s. This threshold has a sensitivity of 100.00%, specificity of 90.91%, accuracy of 94.44%, PPV of 87.5% and NPV of 100%.



## Limitations

- Small sample size
- Unknown inter-rater reliability in terms of the person depressing the reservoir
- Imperfect gold-standard

## Conclusions

Ultrasound with Doppler technology has the potential to be a safe, quick, available and cost-effective screening test for patients with an obstructed shunt. The high sensitivity of the test makes it an attractive option for use as a screening method that could potentially reduce the number of cases requiring radionuclide shunt patency study. Further studies are required to substantiate its reliability, and to see whether mobile phone ultrasound applications would be a suitable substitute.