

# Automatic Segmentation of the Inferior Vena Cava from M-mode Ultrasound Images

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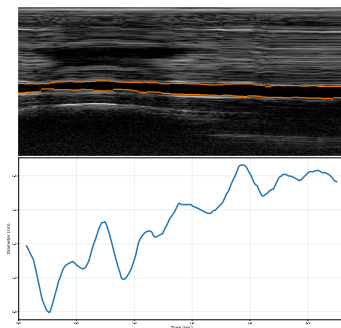
**Aims:** Point-of-care ultrasonography is a widely used diagnostic tool for assessing renal congestion in patients with cardio-renal syndrome (CRS). The Venous Excess Ultrasound grading system (VExUS) has recently been proposed as a systematic assessment of renal congestion in such patients. Its primary goal is the measurement of the inferior vena cava (IVC) diameter from M-mode ultrasound images, a manual task performed during patient evaluation that can be highly observer-dependent. The aim of this work is to propose an automated segmentation pipeline for the IVC diameter measurement from M-mode ultrasound images.

**Materials:** A total of 20 images from 13 CRS patients admitted to the Internal Medicine Department of the Hospital Clínico Universitario Lozano Blesa (Zaragoza, Spain) were processed. The images were acquired using a portable ultrasound device with an abdominal probe and exported in DICOM format.

**Methods:** Images were smoothed using a bilateral filter and binarized. The edges were detected from the binary mask and processed to identify pairs corresponding to the IVC walls, from which the IVC diameter profile was extracted. This profile was smoothed with a running average window of length 5% of the total recording time and the maximum diameter was obtained (see figure).

**Results:** Automated maximum diameter measurements were compared with manual ones made by clinicians. The results showed an error of  $-0.015 \pm 0.318$  cm and a correlation coefficient of 0.864.

**Conclusions:** The proposed IVC segmentation pipeline provided accurate diameter measurements, which may help to improve the assessment of renal congestion in CRS patients.



Example of IVC segmentation (top) and its diameter profile (bottom).