



UMEÅ UNIVERSITET

Umeå University Medical Dissertations, New Series Number 2070

Ultrasound based shear wave
elastography of the liver:
a non-invasive method for
evaluation of liver disease

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Akademisk avhandling

som med vederbörligt tillstånd av Rektor vid Umeå universitet för
avläggande av medicine doktorexamen framläggs till offentligt
försvar i Hörsalen Snäckan, Östersunds sjukhus,
fredagen den 24 april, kl. 09:00.

Avhandlingen kommer att försvaras på svenska.

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Title

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Abstract

Background: Detecting liver disease at an early stage is important, given that early intervention decreases the risk of developing cirrhosis and subsequently hepatocellular cancer (HCC). The non-invasive ultrasound-based shear wave elastography (SWE) has been used clinically for a decade to assess liver stiffness. This method is reliable, rapid and can be performed in an outpatient setting without known risks for the patient. However, increased variance in SWE results has been detected, without clear explanation. Factors that affect SWE results needs to be identified. Data are insufficient regarding the reliability of SWE with different body positions and probe pressures. Men have higher SWE results than women, also for unclear reasons. Increasing the reliability of SWE is crucial for understanding how factors such as overweight and obesity, cardiovascular and antiviral medication, age, sex, smoking habits, hepatic steatosis and cirrhosis affect SWE results.

Aims: The overall aim of the studies included in this thesis was to increase the reliability of SWE liver. The specific aims were to investigate patient-related factors associated with increased uncertainty in SWE results. Another aim was to investigate the influence of increased intercostal probe pressure on liver stiffness assessment with SWE liver. The final aims were to investigate the influence of postural changes, sagittal abdominal diameter (SAD) and skin-to-liver capsule distance (SCD) on SWE results, along with sex-based differences for SWE results and cardiovascular medication.

Methods: All enrolled participants in these studies were consecutive patients with various liver diseases presenting at the radiology department Östersunds Hospital. The patients were examined using SWE liver method at the ultrasound unit between April 2014 and May 2018. Inclusion criteria were that participants be adults (age ≥ 18 years) who had provided written consent for participating in the study. The exclusion criterion was an inability to communicate. Current guidelines for SWE of the liver were used in the thesis with the following exceptions: In study II, increased intercostal probe pressure was used, and in study III, postural change was used. Study I included 188 patients; study II included 112 patients, and studies III and IV involved 200 patients. The four studies were conducted as cross-sectional and clinical trial, using quantitative methods.

Results: Factors associated with low variance for SWE results were age, sex, and presence of cirrhosis, the use of antiviral and/or cardiovascular medication, smoking habits, and body mass index. Factors associated with increased uncertainty in SWE results were increased SCD and the presence of steatosis. With increased probe pressure SCD decreased and the quality of shear wave increased. The results showed that the number of required measurements can be reduced. A postural change to left decubitus decreased SCD. For patients with increased SAD and increased SWE result in the supine position, SWE result decreased with a postural change to left decubitus. The SWE results, SCD and SAD significantly differed between women and men. SWE results was higher in the presence of increased SAD (≥ 23 cm) among men, but not among women.

Conclusions: SWE of the liver is a reliable, non-invasive method for diagnosing liver disease. Results in this thesis suggest that for patients with SCD ≥ 2.5 cm, shear wave measures could be of poor quality and the SWE exam less reliable. In these cases, increased probe pressure may facilitate a reliable SWE exam. With such adjustments in probe pressure, the ultrasound-based SWE method can be superior for examination in patients with overweight or obesity. An effect of SAD ≥ 23 cm was seen for men with liver fibrosis only, which may explain the higher SWE result for men compared to women. Depending on the severity of liver disease and SAD, a postural change to left decubitus can produce a different outcome. As SAD increased, liver stiffness did, as well. Increased SAD thus is linked to increased liver stiffness, indicating that SAD should be taken into account when performing SWE of the liver.

Keywords

Adrenergic antagonist, anthropometric measurement, diagnostic imaging, elasticity imaging technique, blood supply, BMI, body position, fatty liver, liver disease, hepatic steatosis, liver fibrosis, liver stiffness, obesity, postural change, pressure, probe, sex characteristic, shear wave elastography, skin-to-liver capsule distance, transducer and ultrasonography.

Language
English

ISBN
978-91-7855-197-2

ISSN
0346-6612

Number of pages
76 + 4 papers