What is the impact of changing body position on liver stiffness estimates obtained using Point Shear Wave Elastography (PSWE) in fasted healthy volunteers?

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Introduction

Liver fibrosis is major global health problem and represents the common pathway of changes in tissue stiffness as a result of many different types of liver diseases such as viral hepatitis, alcoholic and non–alcoholic liver disease. Fibrosis is a progressive effect and plays a direct part in liver cell dysfunction and can cause resistance to blood flow in the portal vein, known as portal hypertension. Severe fibrosis can evolve into cirrhosis which is when the liver's fundamental structure is deformed and processes are deranged, at this stage the risk of morbidity and mortality is increased. The degree of liver fibrosis determines both prognosis and the treatment pathway, therefore accurately assessing the extent of fibrosis is important.[1]

2D ultrasound is an established modality as a first line tool in the diagnosis, staging and monitoring of liver disease. There are confident 2D US signs to determine end stage fibrosis/cirrhosis, however there are limitations in assessing and grading the degree of diffuse liver disease with 2D US.

Histology from a needle core biopsy (NCB) is the gold standard method of confirming and determining the degree of fibrosis. However NCB has disadvantages such as sampling variability ,risk of bleeding and infection, intra and inter- observer variability. Patient tolerance of an invasive procedure can be particularly problematic for frequent monitoring which is essential for confirming treatment response and informing management decisions[2].Therefore there has been a growing interest in non –invasive quantitative methods of assessing liver stiffness by using ultrasound elastography. The main clinical indications for liver elastography is to determine the stage of fibrosis in those with chronic liver disease and for follow-up scans to assess response to treatment[3].

Aim: To investigate the effect of changing posture on Liver stiffness Elastography measurements (LSEM) obtained using Point Shear-wave Elastography (PSWE) in healthy volunteers.

Materials and Methods

Sixteen healthy volunteers with BMI < 30 kgm^{-2} were fasted for at least 3 hours before being examined by a single operator. Liver stiffness values were obtained using PSWE-ElastPQ with an Affiniti 70 Philips® system and a C5-1 curvi-linear transducer. Ten LSEM (kPa) were performed with participants in standard supine (control), then in left lateral decubitus (LLD) (experimental 1) and semi-erect (SE) (experimental 2) positions. The right lobe of liver was accessed inter-costally on neutral breath hold. Data analysis of the mean LSEM using both Bland Altman assessment for agreement and paired sample T-tests to compare control values with each of the two experimental positions was performed.

Point Shear wave elastography (PSWE) is a relatively new Acoustic radiation force impulse (ARFI) technique used to assess liver fibrosis at a single location, in which the elasticity measurement is obtained by placing a fixed dimension (1.5 x 0.5cm) ROI box over the 2D-US image (Fig 1) within the liver.

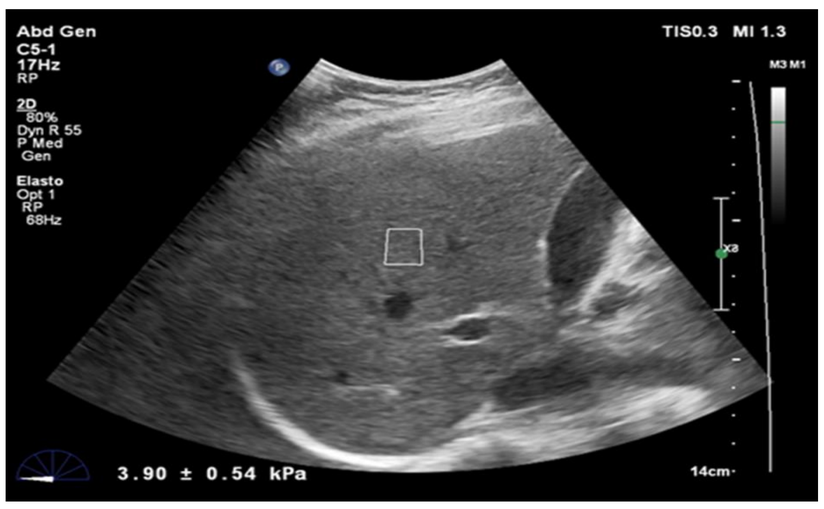

Fig 1. ElastPQ-PSWE measurement for liver stiffness on normal liver displayed over 2D ultrasound image of the right lobe of liver with ROI box placed away from liver capsule and vessels.

The World Federation of Ultrasound in Medicine and Biology (WFUMB) have produced evidence based guidelines for the use of elastography[4]. The guidelines for PSWE include the following recommendations :-

- Fasted Client
- Supine posture with elevated right arm
- Breath hold without deep inspiration
- Region of interest box placed 1.5 - 2cms below liver capsule (Fig 1)
- Avoid large blood vessels
- Median Values of 5 - 10 measurements.

Results (Table 1 and 2)

Median age: 37 years (range 22-61); median BMI 22.2kg/m² (range 17-28). LSEM mean (SD) and median (range) in kPa: Supine: 4.66 (0.85), 4.66 (3.22-6.95); LLD: 4.80 (1.06), 4.65 (3.40-6.95); semi-erect: 5.26 (1.42), 5.23 (2.87-7.68).

Relative to the Supine posture, 75% of participants showed LSEM increased for Semi-erect posture, and 62.5% showed an increase in the LLD posture. Elasticity measurements were presented for the whole sample for each posture in 'Box plots' shown in Fig3. These are useful for displaying continuous data and beneficial to compare variability in data sets across groups.

Experiment 1 resulted in mean difference 0.14, p=0.593 (95% CI -0.41 - 0.69); Experiment 2 showed mean difference 0.59, p=0.027 (95% CI 0.07- 1.11). Bland Altman analysis indicates 95% Limits of Agreement for Experiment 1 (2.22 to -1.98) and Experiment 2 (2.5 to -1.3) (Fig 4).

Table 1 Descriptive Statistics for the mean Values obtained in study sample

	Supine	LLD	Semi-Erect
N	16	16	16
Mean	4.66	4.80	5.26
Median	4.66	4.65	5.23
Minimum	3.22	3.40	2.87
Maximum	6.95	6.95	7.68
Std. Deviation	0.85	1.06	1.42
COV	18%	22%	27%
Range	3.73	3.55	4.81
IQR	0.99	1.92	2.42

Table 2 Mean LSEM per participant for each posture (kPa)

	Supine	LLD	Semi-Erect
1	4.46	3.86	5.9
2	3.67	3.92	4.32
3	3.22	3.4	2.87
4	5.4	3.47	3.99
5	5.24	4.84	6.29
6	4.83	5.94	6.78
7	5.2	4.63	6.68
8	6.95	5.99	7.68
9	4.74	5.37	7.21
10	4.53	6.95	5.07
11	4.89	6.26	5.16
12	4.63	4.67	5.43
13	4.49	5.23	4.22
14	3.67	4.18	3.15
15	4.7	3.84	5.31
16	4.02	4.37	4.14

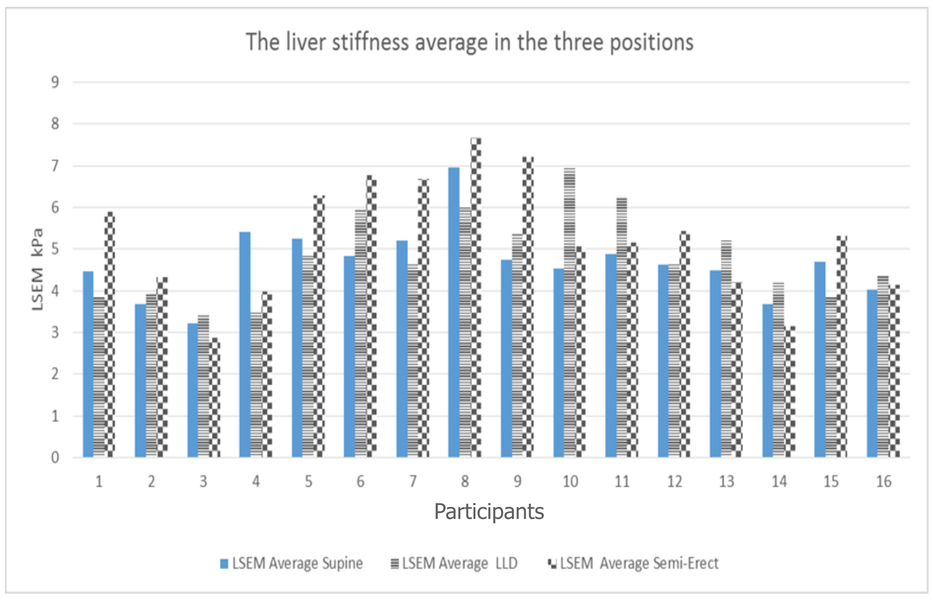

Fig 2 Shows the changes in the mean LSEM per participant for each posture.

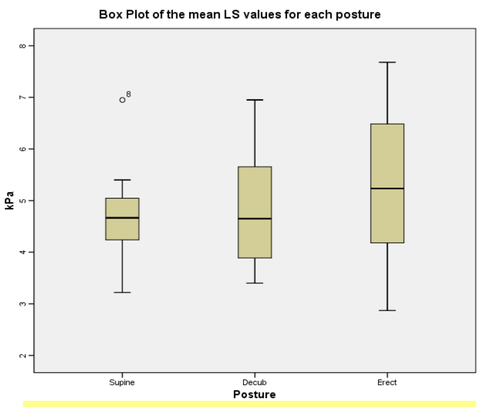

Fig 3 Box Plots for LSEM for each posture.

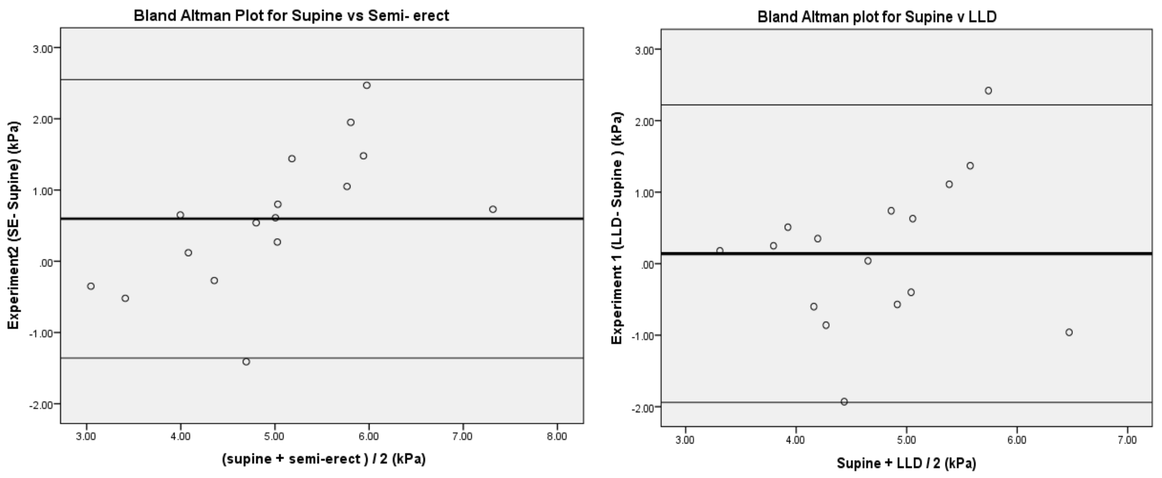

Fig 4
Bland Altman Analysis for Experiment 1 and 2

Both experimental postures LLD and SE showed increased variability in LSEM relative to the supine control. However the statistical tests and Bland-Altman analysis has shown the greatest differences are noted in the semi-erect posture. The statistically significant difference for SE posture suggests this could lead to higher liver stiffness grading, by up to 1kPa in this healthy group. Measurements in this posture could lead to incorrect fibrosis staging and thus impact clinical decisions for patient management, therefore scanning in semi-erect postures is not recommended.

Although no statistically significant mean difference for Supine v LLD measurements suggests these postures are interchangeable in clinical practice, the wide Limits of Agreement (approx. 2kPa) derived from Bland Altman analysis for both experimental postures suggests changing posture could have a clinical impact, particularly in mild/moderate fibrosis categories due to the narrower cut-off ranges.

Conclusion

Results of this study suggest measurements should be performed in supine posture where possible, or that the same posture is maintained for patients undergoing serial surveillance scans. Further studies are required to prospectively test these findings in those with chronic liver disease, in which different cut-off values for different stages of liver disease occur. This will be useful in developing reliable and reproducible methods of measurements in clinical practice.

References:-
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