

Lumbar Ultrasound Measurements are Imprecise when Compared with MRI:

Is it more than Soft Tissue Compression?

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Introduction

Preprocedural lumbar sonography may be used to plan epidural and spinal insertion and so increase first pass success, procedural success and patient satisfaction. Measurements assist in interspace and needle selection.[1] How accurate are these measurements, particularly measurements of interlaminar space dimensions or depth?[2]

Methods

Ethics approval was obtained for examination and imaging using ultrasound and magnetic resonance imaging (MRI) of the lumbar spines of healthy young adults (18 – 20 years). Multiple equivalent measurements were taken (T12 - S1). Minimal force was used during ultrasound. Ultrasound measurements were recorded from paramedian oblique and transverse probe orientations. Maximal ultrasound measurement values were used for depth observations and mean for all other multiple planned sequential observations. A single set of MRI measurements were taken from a midline, mid-interspinous space/mid-spinous process axis for each vertebral/interspace level.

Discussion

Compression of overlying subcutaneous tissue is intrinsic to the application of an ultrasound probe. This compression is the greatest source of inaccuracy. Ultrasound measurements that do not include subcutaneous tissue are accurate but imprecise at **+/-1cm** when compared with MRI derived equivalent measurements.

Results

The 27 volunteers (16 female, 11 male) were a judged to be a representative sample of a normal but diverse population with normal lumbar anatomy. All ultrasound measurements were highly correlated with MRI, $r^2 = 0.88$ ($p < 0.0001$) but were inaccurate and imprecise. (See Figure & Table) The whole group was divided into simple depth measurements which included subcutaneous tissue and all measurements without subcutaneous tissue. The no subcutaneous tissue measurements group was further analysed according to overlying subcutaneous tissue thickness ($\neq$ subcutaneous median), ultrasound probe orientation, and measurement alignment with ultrasound beam direction. Additionally, measurements recorded using a **transverse** orientated ultrasound probe when compared against **paramedian oblique** were also found to be **inaccurate** [$n = 1116$, **bias = -0.5 mm**, 95%CI = 1.1 — -0.1mm, Limits of Agreement (LOA) = **-16.9 - 15.7 mm**].

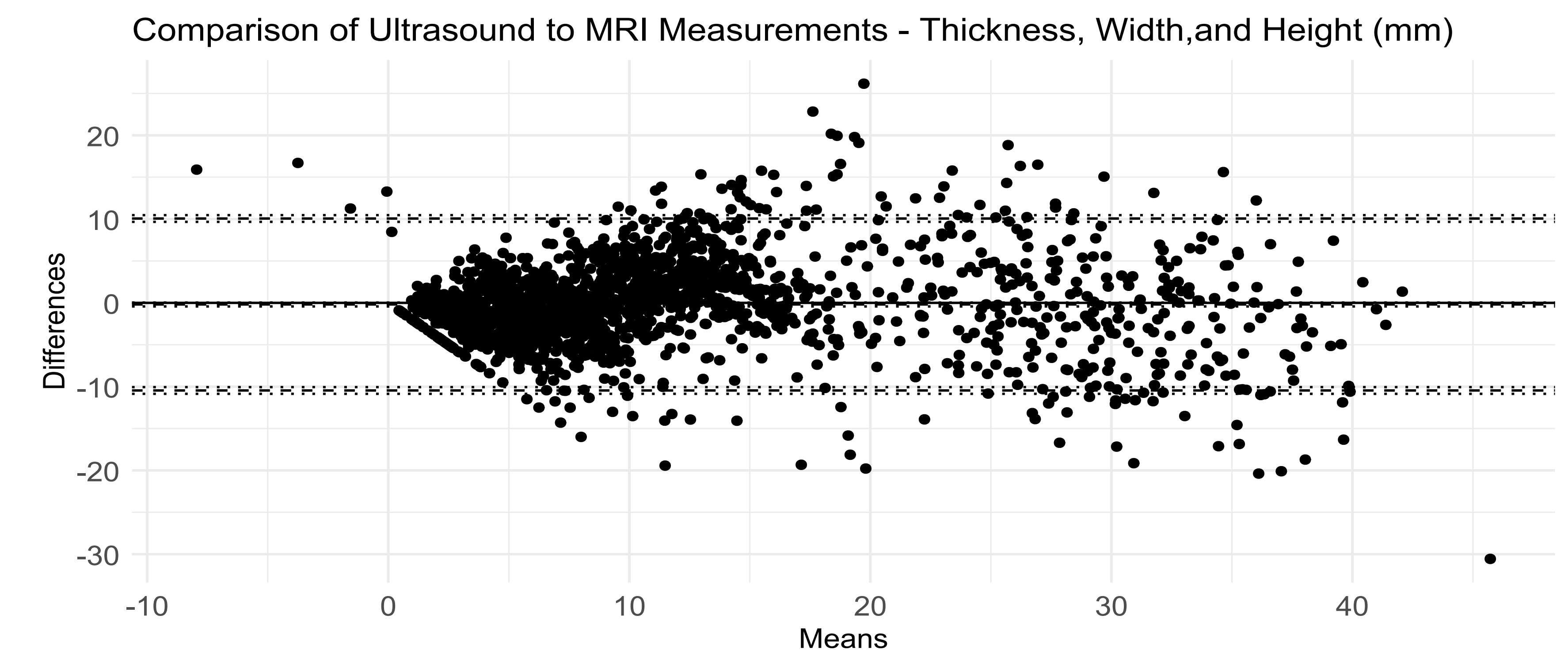


Figure: Bland-Altman Analysis of Agreement, Ultrasound Compared with MRI

Table: Bland-Altman Analysis of Agreement Ultrasound Compared with MRI

	Number	Bias, 95% CI (mm)	LOA (mm)	Accurate	Precise
All Measurements	4202	4.7 , 4.4 - 4.9	-13.1 - 22.4	No	No
With or Without Subcutaneous Tissue					
Depth Measurements	2275	8.7 , 8.3 - 9.1	-10.3 - 27.5	No	No
No Subcutaneous Tissue Measurements	1927	-0.2 , -0.4 - 0.1	-10.7 - 10.1	Yes	No
No Subcutaneous Tissue Measurements are Included Below					
By Overlying Subcutaneous Tissue Thickness					
< Subcutaneous Median	978	0.1 , -0.2 - 0.4	-9.3 - 9.5	Yes	No
> Subcutaneous Median	949	-0.4, -0.8 - -0.1	-11.6 - 10.8	No	No
By Probe Orientation					
Paramedian Oblique	633	0.1, -0.2 - 0.5	-8.1 - 8.3	Yes	No
Transverse	1294	-0.3, -0.6 - -0.001	-11.5 - 10.9	No	No
By Measurement Orientation					
Parallel	1258	-0.7, -1.0 - -0.4	-11.6 - 10.1	No	No
Perpendicular	669	0.9, 0.6 - 1.3	-8.0 - 9.8	No	No

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References

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- 2 Singh N, Pritzlaff S, Bautista B, et al. Correlation between epidural space depth measured with ultrasound and MRI compared to clinical loss of resistance when performing lumbar epidural steroid injection. RAPM. 2024;49:871-876

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