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Technical and measurement report

Manual palpation of lumbo-pelvic landmarks: A validity study

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ABSTRACT

Manual palpation (MP) is commonly used for the assessment of patients with neuromusculoskeletal dysfunction. During assessment of lumbo-pelvic disorders in particular, it may be used not only to explore pain and resistance in the region, but also to evaluate the symmetry and movement quality of the area. Whilst reliability of MP has been extensively investigated, its validity remains relatively under researched. The aim of this study was to explore the accuracy of MP of lumbo-pelvic bony points. Ultrasound images of three bony landmarks [4th lumbar spinous process (L4), left and right posterior superior iliac spines (PSIS)] were acquired from models ($n = 3$) in the prone position and the points marked with an ultra-violet (UV) pen. Nine musculoskeletal physiotherapists were asked to identify the bony landmarks using MP. Measurements (mms) were taken between the UV marks and the palpators' marks. The mean error (standard deviation) (mm) for MP of L4, LPSIS, RPSIS were 15.63 (3.89), 20.07 (4.60), 20.59 (2.79) respectively. Bland and Altman analysis gave a mean value of 0.173, with 95% limits of agreement ranging from −27.8 to 26.3. This study suggests that MP of specific lumbo-pelvic bony points has limited validity.

1. Introduction

Non-specific low back pain (LBP) affects around one third of the population per year, resulting in one in fifteen people consulting their general practitioner (NICE CG88 2009). The growing costs of LBP (Dagenais et al., 2008) have potential work load implications for physiotherapists who can offer manual therapy, advice and guidance on exercise or acupuncture (NICE CG88 2009).

With sacroiliac joint (SIJ) dysfunction reportedly accounting for up to 30% of all LBP presentations (Maigne et al., 1996), differentiation between dysfunction in the lumbar spine or the sacroiliac area is important. According to Van der Wurff et al. (2006), assessment of the SIJ involves three categories of test, those of pain provocation, static position and motion palpation. All these tests involve manual palpation (MP), and are dependent on the need to accurately identify specific anatomical bony points. Static position and motion palpation explore symmetry, so a lack of accuracy when palpating bony landmarks could affect the validity of associated clinical tests. A study investigating the assessment of bony landmark symmetry, including the PSISs showed only slight reliability (O'Haire and Gibbons, 2000). Inaccuracy in the MP of each landmark may have contributed to this result.

While several studies have explored lumbo-pelvic MP *reliability* (Simmonds and Kumar, 1993; McKenzie and Taylor, 1997; Downey et al., 1999; Billis et al., 2003; Robinson et al., 2009), few have explored MP *validity*. Ethical issues associated with imaging studies such as radiation exposure, in addition to availability and expense may partly account for this.

Validity of MP has been evaluated using a range of imaging tools, different professions and with different aims; a summary is presented in Table 1.

Reported level of agreement between MP of lumbar spinous processes and imaged bony landmarks have varied from moderate to good for MRI (Broadbent et al., 2000), and X-ray (Harlick et al., 2007). Furness et al. (2002) provides some validity for US imaging of bony landmarks, although the palpators were anaesthetists and subjects were moved between measures.

Watson et al. (2003) explored the criterion validity of US imaging using MRI, however subjects changed body position between measures. The results suggest that it is possible that all markers were actually positioned correctly and the position change added a variable. The validity of US as a superficial bony landmark identifier could therefore be improved. Studies have been identified comparing US with both X-ray and MRI, however subject movement or position change between assessments occurred in every study.

The aim of this study was to explore the validity of palpation of a specific point in the lumbo-pelvic region using US.

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Table 1
Key studies investigating palpation validity.

Authors	Participants	Method	Results	Comments
Broadbent et al. (2000)	100 symptomatic models, 4 **anaesthetist** palpators	**Palpation** of randomly marked lumbar interspinous space by two raters for each subject. **MRI** identification of space.	Average weighted Kappa: .52. Correct level identified by palpation: 28%	• 3 changes of position prior to MRI • Symptomatic models
Furness et al. (2002)	50 symptomatic models, 3 **anaesthetist** palpators	**Palpation** of 3 lumbar interspinous spaces marking with UV pen. Operator blinded identification with **US** and marking with metal pellets. Subsequent identification using **X-ray.**	Correct interspinous identification with US: 70% With palpation: 30% $P < 0.001$	• The only study comparing palpation, US and X-ray. • Provides limited criterion-related validity to both palpation and US • Change in position • Symptomatic model
Harlick et al. (2007)	75 symptomatic models, 5 **physiotherapy** palpators	**Palpation** of L1, 3, 5 followed by **X-ray.**	Mean palpation accuracy 47% across levels.	• Age, gender and BMI no effect • Change in position • Symptomatic models
Kim et al. (2007)	72 models, 4 **physician** palpators	**Palpation** of PSIS and iliac crests with **X-ray**	Mean discrepancy values of 0.59 cm–0.6 cm for PSIS	• Insufficient detail provided relating to methodology and results.
Robinson et al. (2009)	49 patient models (18 cervical, 31 lumbar), 2 **physiotherapist** palpators	Evaluation of specific **palpation** technique for identifying C7 and L5, with **X-ray** assessment of validity.	C7 identified in 55% and 72% models. L5 identified in 48% and 36% models.	• Symptomatic models
Pysyk et al. (2010)	114 patient models, one **physician** palpator	**Ultrasound** assessment of the vertebral level of the **palpated** intercristal line	Palpated intercristal line found between: L3-4 73% L2-3 13% (10% male) L4-5 14%	• US identification of lumbar landmarks

2. Method

2.1. Research design

A prospective exploratory study with blinding of palpators.

2.2. Ethics

Ethical approval from the School of Health and Population Sciences, University of Birmingham with adherence to institutional Research Governance Guidelines was gained, with all subjects giving informed consent.

2.3. Subjects

Bruton et al. (2000) recommended a minimum of 25 degrees of freedom in reliability studies, consisting of a multiple of the number of palpators and models. Accordingly, a convenience sample of 3 models and 9 physiotherapists were recruited from the postgraduate Masters in Manual Therapy programme.

Palpators were excluded if they had any upper limb abnormality which could affect their MP ability. Their level of musculoskeletal experience was noted.

Models were excluded if found to have a current or previous neuromusculoskeletal spine condition, or were unable to lie prone for the duration of the study.

2.4. Equipment

US images were acquired using a GE Logiq-e 12L high resolution portable US machine (GE Healthcare, Hertfordshire, UK) with a 12L (7–13 Mhz) linear array transducer. A large metal paperclip was used to generate an acoustic shadow on the acquired image (Bianchi and Zamorani, 2007). UV pen and light (www.jnemarketing.com) initially marked the skin. Error was measured using callipers and millimetre rule. Skin marks were made using a washable pen. Models were positioned on manipulation plinths (Akron, UK).

2.5. Procedure

A pilot study determined the feasibility of the study.

Bony points identified were the inferior surface of the L4 spinous process (sp) and the inferior surfaces of the right and left PSIS. The L4sp is more superficial and larger than L5 and is therefore potentially easier to palpate (McKenzie and Taylor, 1997; Billis et al., 2003) with superior reliability (Downey et al., 1999). The most caudal point was chosen because the potential for error was likely to be less than choosing to identify the midpoint of the structure. The average length of the L4sp is 20.8 mm (Downey et al., 2003) and the margin of error when selecting the midpoint of the structure could be therefore be as large as 20.8 mm. This level of error is acceptable for a spinal bony point, but not for points where symmetry is assessed, such as the PSISs. The caudal point of the PSIS tends to be easier to palpate.

Models were positioned prone, with arms by their sides, head and neck in neutral, using the breathing hole. A musculoskeletal ultrasonographer (MM) acquired US images of the bony landmarks, then placed the metal marker longitudinally over the point to generate an acoustic shadow (Bianchi and Zamorani, 2007) (Fig. 1).

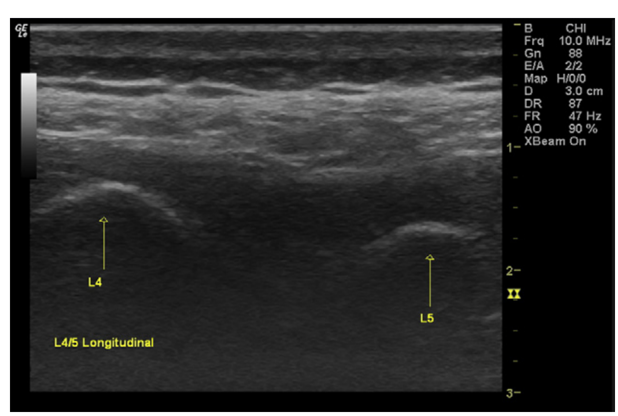

Fig. 1. Ultrasound image of the L4 and L5 spinous processes. The L5 is smaller, and the apex of the spinous process is clearly shown.

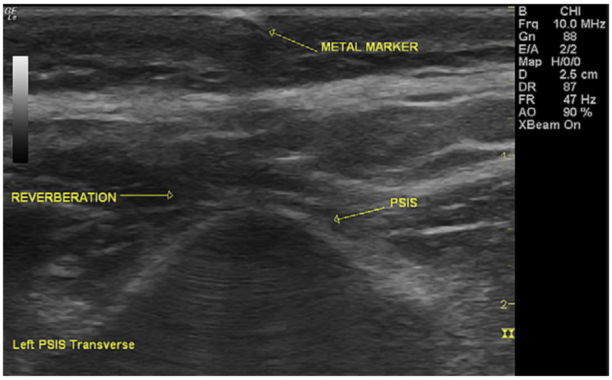

Fig. 2. Ultrasound scan image of the LPSIS (transverse view). The faint line running through the centre of the image is reverberation artefact caused by echoes from the sonic wave bouncing back and forth between the transducer face and the metal marker used to identify the bony point. Transverse and longitudinal views were obtained using this technique to identify and confirm the distal aspect of the bony point, ensuring that the UV marks on the skin were over the point identified.

The marker was pressed onto the skin to create a temporary imprint. This was repeated with the marker placed perpendicular to the imprint at the most caudal point (Fig. 2). These imprints allowed skin marking with UV pen on removal of gel. The imprints remained visible for a maximum of 2 minutes on all models.

The procedure was explained and the exact location of the points to be palpated identified on a spinal model. Palpators were encouraged to palpate the L4sp from caudad to cephalad using the pulp of the thumb to maximize the chance of identifying the most caudal aspect of each point. For the PSISs, they were instructed to palpate the iliac crests distally until their thumbs reached the inferior surface of the structure (O'Haire and Gibbons, 2000). Palpators identified the three points on each model and marked each with a cross using a washable pen. An assistant measured the distance between the visible points and the UV points. Ink marks were removed between each test and the UV marks rechecked. The researcher ensured skin was clear of marks or discolouration before the next palpation took place. If the model needed to move off the couch, the marks were reassessed using US. No feedback was provided by the models or research team throughout the study.

All testing was performed on one occasion with environmental conditions maintained throughout the duration of testing.

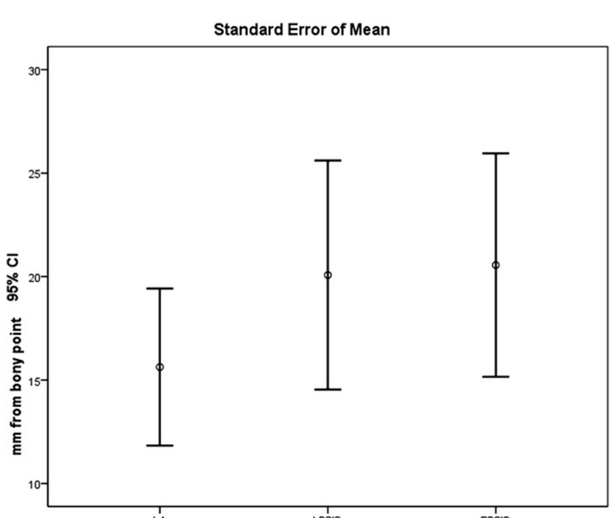

Fig. 3. Error bars, with mean and standard error of mean for L4 and R and LPSIS.

2.6. Data analysis

The individual and group data were analyzed to derive the distance between the palpated and imaged landmarks. The data is presented descriptively with means, SD, error bars and calculation of Intra-class Correlation Coefficients (ICCs). These were calculated for palpators marking each bony point and for all the points together. Of the six types of ICCs, model 3,1 was selected. This model was used because a convenience sample of palpators was recruited (Shrout and Fleiss, 1979). With ICC 3,1, the 95% confidence interval is not calculated because inference to a population of palpators is not intended (Shrout and Fleiss, 1979; Sim and Wright, 2002).

Bland and Altman plots were constructed using paired data from the models, for comparison. Data from model A was paired with data from model B, pairing the measurements from the same palpator. In the same way, model B was paired with C, and C with A. All data analysis was performed using SPSS version 17.00, where $p < 0.05$.

3. Results

3.1. Participant characteristics

Palpators' mean time since physiotherapy qualification was <3.5 (2.9) years. 66% of palpators treated lumbo-pelvic pain patients at least weekly, having more than 1500 h of post registration experience of treating patients with neuromusculoskeletal conditions.

Models' mean Body Mass Index (BMI) was 25.3 (SD 4.0), 2 males, 1 female.

3.2. Results

The mean error (standard deviation, mm) for L4, LPSIS, RPSIS were 15.63 (3.89), 20.07 (4.60), 20.59 (2.79) respectively (Fig. 3). ICCs are represented in Table 2.

Normality of data was assessed prior to construction of Bland and Altman plots for all points (Fig. 4). The mean Bland and Altman plot difference for all points was 0.173.

4. Discussion

The aim of this study was to explore the validity of MP of specific bony points in the lumbo-pelvic region. There are few studies with which to compare the results, most being within the anaesthetic literature.

The results suggest that validity of MP to locate a specific bony landmark is limited with a mean error of 18.8 mm for all points, and wide variability. The error was consistent between the two PSISs, but less for L4, suggesting that MP of the L4 spinous process may be marginally better. This may be because the landmark is more superficial or reflect the experience of the palpators in locating PSIS. While an ICC of 0.821 appears encouraging, the use of ICCs without further analysis can be misleading since they are strongly affected by sample heterogeneity such that a high correlation may still indicate unacceptable measurement error (Sim and Wright, 2002). Comparison with existing literature is difficult due to the

Table 2
Results for palpator measurements: ICC.

Points	ICC (3,1)
	Coefficient (significance)
All points	0.81 ($p = 0.00$)
L4	0.83 ($p = 0.00$)
LPSIS	0.68 ($p = 0.03$)
RPSIS	0.58 ($p = 0.06$)

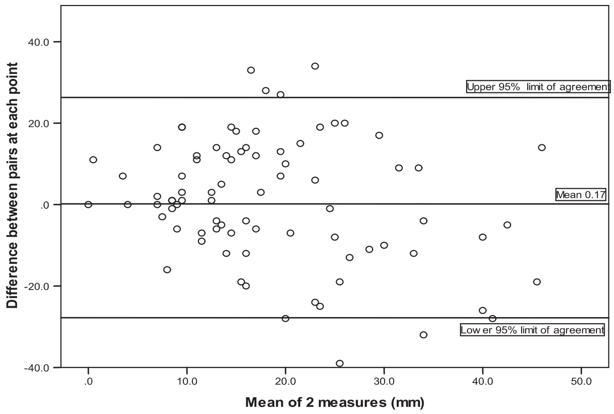

Fig. 4. Bland and Altman plot representing the differences and means of paired measurements at all points, by all raters on each model. The mean and upper and lower limits of agreement are depicted.

use of symptomatic subjects, changing positions during testing or in adequate reporting of results (Broadbent et al., 2000; Furness et al., 2002; Harlick et al., 2007).

The limited number of studies exploring the validity of US as a tool for bony point identification is relevant to this study. However, the image transmitted by the probe gives a very clear view of bone as a contrast to the surrounding tissues, providing face validity to this form of bony assessment (Figs. 1 and 2). Watson et al.'s work (2003) suggests that US is potentially as precise as MRI and provides a cheaper, more accessible tool to potentially support training in the palpation of superficial bony landmarks.

Other studies have reported the use of UV pen for skin marking (Burton et al., 1990; Simmonds and Kumar 1993; McKenzie and Taylor, 1997; Downey et al., 1999; Billis et al., 2003; Robinson et al., 2009), generally identifying the midpoint of the structure and transcribing the marks onto transparencies. Agreement using this method has been found to be perfect (McKenzie and Taylor, 1997), although transposing marks onto another medium and then measuring them is a potential source of error. Marking of the skin with washable ink pens and taking measurements directly reduced this error risk. If the most distal point of each landmark is identified, it may further reduce the margin of error.

A critical consideration was to perform the study without moving or changing the models' position between US assessment and MP, since position change was a factor potentially affecting error in previous studies (Furness et al., 2002; Watson et al., 2003; Harlick et al., 2007). The availability of simple reassessment with US would not have been possible with other imaging techniques. No studies have been identified which have investigated skin movement during MP, although it has been acknowledged as a source of error (McKenzie and Taylor, 1997; Harlick et al., 2007).

While the literature suggests that MP is an unreliable tool for landmark identification (Haneline and Young, 2009), studies using experienced palpators have demonstrated acceptable or improved reliability (Downey et al., 1999; Billis et al., 2003; Harlick et al., 2007). The degree of error noted in this study may reflect the sample of palpators, having experience of, but not expertise in manual therapy. Further research investigating the effects of specialist training on MP validity is recommended.

Although the BMI indices for two of the three subjects in this study are slightly above acceptable WHO recommendations (World Health Organisation, 2010), no correlation has been identified regarding MP reliability (Harlick et al., 2007).

Further studies, recruiting a larger sample size of both models and palpators and additional clinically relevant bony points would assist in the generalisability of these results. The effect of other variables on the validity of MP, such as BMI, training and subject positions, warrants further investigation.

5. Conclusion

This is the first study that has sought to explore the validity of MP of specific landmarks in the lumbo-pelvic area, using US. The findings suggest that MP may have acceptable validity when used for applying manual therapy. However, the degree of measurement error found in this study may be unacceptable when assessing for pelvic symmetry.

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