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Reliability of the inter-rectus distance measured by palpation. Comparison of palpation and ultrasound measurements

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Abstract

An increased inter-rectus distance (IRD) is a common condition in late pregnancy and in the postnatal period. The condition is difficult to assess. Palpation is the most commonly used method to assess IRD. To date there is scant knowledge of intra and inter-tester reliability of palpation to measure IRD and how palpation compares with ultrasound measurements.

The aims of this study were: 1) evaluate intra and inter-rater reliability of abdominal palpation; 2) validate abdominal palpation of IRD measurements using ultrasound imaging as a reference.

Two physiotherapists (PTs) conducted the palpation study in random order, blinded to each other's assessments. IRD was measured as finger widths between the two rectus abdominis (RA) muscles. Ultrasound images were recorded at the same locations as the palpation test. A blinded investigator measured the IRD offline.

Palpation showed good intra-rater reliability between days expressed by a weighted Kappa (wK) higher than 0.7 for both physiotherapists, and moderate inter-rater reliability (wK = 0.534). Ultrasound was found to be more responsive for differences in IRD compared with values obtained by palpation.

The intra-rater reliability was higher than the inter-rater reliability. Besides the difference in experience with palpation testing between the PTs, this result may be due to differences in finger width and/or the subjective interpretation of abdominal soft-tissues pressure. Ultrasound measures are highly sensitive to changes of IRD, which is not possible to replicate by palpation assessment using a finger width scale.

Palpation has sufficient reliability to be used in clinical practice. However, ultrasound is a more accurate and valid method and is recommended in future research of IRD.

Keywords

Diastasis; Reliability; Palpation; Ultrasonography

1. Introduction

The lateral-anterior abdominal wall consists of five paired muscles with fibers oriented vertically, horizontally and obliquely. These muscles have skeletal attachments on the thoracic cage and pelvis and also on the spinal column via the thoracolumbar fascia. The right and left sides of the abdominal wall are connected via the Linea Alba aponeurose. During pregnancy the Linea Alba reduces the resistance to tension and the two bellies of the rectus abdominis (RA) curve round the abdominal wall, increasing the midline separation of the two RA muscles along the Linea Alba (Boissonnault and Blaschak, 1988; Fast et al., 1990; Gilleard and Brown, 1996). This gap, the Inter Rectus Distance (IRD) is often referred as diastasis recti abdominis (DRA) (Noble, 1995; Spitznagle et al., 2007; Coldron et al., 2008). Studies have found that an increased DRA may affect between 30% and 70% of women during pregnancy (Boissonnault and Blaschak, 1988), and that it may remain separated in the immediate postpartum in 34.9% (Boissonnault and Blaschak, 1988) to 60% of women (Bursch, 1987; Boissonnault and Blaschak, 1988; Boxer and Jones, 1997). Knowledge of changes in RA postpartum is important for the development of effective postnatal exercise programmes and general postnatal advice (Coldron et al., 2008). In physiotherapy the most commonly used assessment methods to evaluate IRD are palpation (Bursch, 1987; Boissonnault and Blaschak, 1988; Noble, 1995; Mantle et al., 2004) and calipers (Boxer and Jones, 1997; Hsia and Jones, 2000). However, the reliability of these methods is unclear. Newer methods are available to access muscle and connective tissues morphometric parameters, such as Computed Tomography (CT), Magnetic Resonance Imaging (MRI) and Ultrasound Imaging. Recently, Mota et al. (2012) found ultrasound imaging to be a reliable method for measuring IRD. Nevertheless, in clinical practice, palpation may still be the most commonly used method, as it is easy to apply, does not require special equipment and has a low financial cost. Accurate and reliable palpation skills are prerequisites for correct measurements (Simmonds and Kumar, 1993). In the literature only one study was found assessing inter-rater reliability of IRD measurement by palpation (Bursch, 1987) and no studies were found comparing palpation and ultrasonography. The aims of the present study were to evaluate intra and interrater reliability of abdominal palpation, and to compare the results from abdominal palpation with 2D ultrasound imaging of the IRD.

2. Methods

2.1. Design

This is a test-retest study to evaluate the intra and inter-rater reliability of IRD measured by palpation and a criterion validity study using ultrasonography as the gold standard. For the palpation test-retest, two test sessions with two physiotherapists with different experience in the use of the palpation test were conducted. During the first session one of the physiotherapists conducting the palpation test also performed the ultrasound measurements.

2.2. Participants

The participants were recruited from a private physiotherapy clinic and among colleagues, friends and family. The participants were eligible for the study if they agreed to participate in two testing sessions and were able to perform the abdominal crunch exercise. The study was approved by the Review Board of the Technical University of Lisbon, Faculty of Human Kinetics. Signed informed consent was obtained before participation and the rights of the participants were provided verbally, as well as in written form.

2.3. Assessors

Two physiotherapists conducted the palpation study: one had 31 years of experience as a women's health physiotherapist (PT) and in palpation of the IRD, the other had 7 years of experience. The palpation tests were performed in random order between the two physiotherapists, and they were blinded to each other's assessments.

The physiotherapist performing the ultrasound imaging was trained by an experienced radiologist.

2.4. Procedure

The subjects were in supine resting position with the knees bent at 90° and feet resting on the plinth, arms alongside the body (Fig. 1). After instruction in how to perform an abdominal crunch (Fig. 2) the subjects were asked to raise the head and shoulders upwards until the shoulder blades cleared the table. One physiotherapist placed the fingers vertically on the subject's Linea Alba in a way that fingers widths could fit the distance between the internal borders of the two rectus abdominis muscles. Using the center of the umbilicus as a reference, measurements were taken in two previously marked locations: one being 2 cm above the umbilicus and the other being 2 cm below the umbilicus. After 2 min rest the procedure was repeated by the second physiotherapist. After the abdominal palpation, ultrasound images were taken at the same locations and during the same conditions by one of the physiotherapists (Mota et al., 2012).

2.5. Ultrasound imaging

An ultrasound scanner (GE Logic-e) with a 4e12 MHz, 39 mm linear transducer was used to collect images in brightness mode (B-mode).

During image acquisition the bottom edge of the transducer was positioned to coincide with the corresponding skin marker (Fig. 3) and moved laterally until the medial borders of both RA muscles were visualized (Mota et al., 2012). The orientation of the transducer was then adjusted to optimize visualization of the image. Images were collected immediately at the end of exhalation, as determined by visual inspection of the abdomen following the recommendations of Teyhen et al. (2008). Additionally, particular attention was paid to the pressure imposed on the probe in order to avoid reflexive response from the participants.

The intra-rater reliability of the same ultrasound images on IRD has been found to be very good with intra-class correlation coefficient (ICC) values above 0.90 (Mota et al., 2012).

The abdominal crunch exercise was started from the resting position and the subjects held the final position of the exercise until told to return to the starting position.

The set of images on both locations (2 cm above and below the umbilicus) were exported in JPG format and analyzed offline by the same investigator, using a customized Matlab code (Image Processing Toolbox, Mathworks Matlab, USA) following the procedures described by Mota et al. (2012).

2.6. Statistical analyses

The level of agreement on palpation between the two days of measurements (intra-rater) and between the two testers (interrater) was determined by means of Spearman's rho and weighted Kappa (Cohen, 1968).

The scale from Landis and Koch (1977) was used in the classification of the reliability values. Weighted Kappa values under 0.20 were considered poor, 0.21e0.40 fair, 0.41e0.60 moderate, 0.61e 0.80 good and 0.81e1 very good. Mean of IRD measured by ultrasound was used to estimate 95% confidence intervals (CI) for each palpation category (as finger widths) and a one-way analysis of variance (ANOVA) test was used to compare mean differences (Bø and Finckenhagen, 2001). The level of significance was $p < 0.05$.

3. Results

Twenty healthy female volunteers, mean age 29.3 years (range 16e49), body mass index 23.01 BMI kg/m² (range 18.90e28.51) and mean parity of 0.7 children (range 0e2), participated in this study. Twelve of the women were in the postpartum period.

All participants returned for the second test after a mean of 3.9 days (Standard Deviation SD 3.9) (range 1e16). The results of the intra-rater reliability test of palpation for the experienced physiotherapist are presented in Table 1. There was agreement across days in 32 of the 40 cases (80%). The reliability when measured by Spearman's rho was 0.812 ($p < 0.01$) and weighted Kappa was 0.766.

The results of intra-rater reliability for the less experienced physiotherapist are presented in Table 2. There was agreement in 29 of the 40 cases (72.5%) across days. The reliability when measured by Spearman's rho was 0.764 ($p < 0.01$) and weighted Kappa was 0.732.

The inter-rater reliability of the measurements obtained by palpation by the two physiotherapists is presented in Table 3. There was agreement between the two physiotherapists in 25 (62.5%) of the cases. The reliability when measured by Spearman's rho was 0.702 ($p < 0.01$) and weighted Kappa was 0.534.

Table 4 displays means and 95% CI of IRD measured by ultrasound for each palpation category for both physiotherapists. There were no differences between these categories (as finger widths) for the experienced physiotherapist, when comparing average IRD measured by ultrasound ($f = 1.594$, $df = (4;35)$, $p = 0.198$). For the less experienced physiotherapist there were significant differences between the palpation categories when comparing average IRD measured by ultrasound ($f = 7.024$, $df = (3;36)$, $p = 0.01$).

4. Discussion

The current study examined the intra and inter-rater reliability on IRD measurements. Our results showed that the intra-rater reliability of palpation can be considered good for both physiotherapists while the inter-rater reliability was moderate. The results for Spearman's rho can be considered good. However, there was a lack of agreement between the two raters, which was not revealed by the use of Spearman's rho.

As expected, the measurements made by the same physiotherapist were more reliable than the measurements made by two different raters. Besides the difference in experience of palpation testing, this may be due to differences in the width of fingers and subjective interpretation of pressure (Bursch, 1987).

The only previous study assessing inter-rater reliability (Bursch, 1987) concluded that palpation was an unreliable method to assess IRD. This is in contrast to our study. However, the study populations differ as the study by Bursch (1987) assessed postpartum women less than four days after delivery. In addition, different procedures and statistical methods were used. Bursch (1987) tested the inter-rater reliability of palpation in one location on the Linea Alba, and four physiotherapists with different levels of experience participated. ANOVA for repeated measures were used to analyze the data.

Choosing a gold standard method to test criterion validity is not a simple task. Computed tomography (CT) and magnetic resonance imaging (MRI) are currently considered the methods of choice to examine the abdominal wall. However, these methods are expensive and CT exposes the

patient to radiation (Mendes et al., 2007), making it impossible to use in pregnant women. Hence, ultrasonography has been proposed as a safe and non-invasive technique that can be repeated several times (Mendes et al., 2007) during pregnancy. Coldron et al. (2008) used ultrasound to characterize RA changes during the first year postpartum and Mendes et al. (2007) claimed ultrasonography to be an accurate method to measure DRA above and at the umbilicus when compared with surgical compass during abdominoplasty. Recently Mota et al. (2012) found very good reliability for IRD measurements with ultrasound.

Given that palpation values 0, 0.5, 1, 1.5 and 2 finger widths allow a numerical interpretation for IRD comparable to the IRD values obtained by ultrasound this study found a lack of correspondence for one physiotherapist and some correspondence for the other physiotherapist. When comparing the IRD values obtained by palpation with the ones obtained by ultrasound, it was found that ultrasound was more responsive for differences in the distance between the two muscles. Ultrasound measures the IRD in mm and such levels of assessment are difficult to detect by palpation. Palpation categorizes results on 4 or 5 point scales with a grading system ranging from 0 to 2 finger widths. Hence, the palpation may not have sufficient responsiveness to differentiate between individuals.

A strength of the present study is the blinding of the two raters to the palpation results, and to all IRD measurements with the ultrasound until the end of the process. The comparison with a gold standard already tested for reliability can also be considered a strength. To ensure external validity, 12 subjects in the postpartum period and 8 subjects with different parity, were included in the study.

The limitations of the present study include the use of only two raters with different experience in palpation of IRD and inclusion of only healthy subjects without any musculoskeletal or neurological symptoms. It may be more difficult to reliably measure subjects with symptoms that can interfere in the performance of the abdominal crunch across the days in the immediate postpartum period. Another limitation of this study may be that it is a convenience sample and that the subgroups are small. This may explain the differences between the two raters when comparing their palpation and ultrasound measurements.

5. Conclusion

Good intra-rater reliability for palpation of IRD was obtained across days for both an experienced and a less experienced physiotherapist, while inter-rater reliability was moderate. Palpation can be used in clinical practice. However, ultrasound is a more reliable and valid method. The results of the present study suggest that ultrasound should be used in future research of IRD.

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This study was approved by the Review Board of the Technical University of Lisbon, Faculty of Human Kinetics, Portugal.

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Fig. 1. Rest position and start position for the abdominal crunch exercise. The subject was supine, in the crook lying position, arms resting along the body.



Fig. 2. Abdominal crunch. End position for the abdominal crunch exercise. The subject was supine, in the standard crook lying position, hands touching the knees.



Fig. 3. Position of the transducer for the ultrasound imaging.

Table 1Experienced physiotherapist palpation intra-rater reliability across 2 days of measurements. $N = 40$.

Number of finger widths		Palpation day 2					Total
		0	0.5	1	1.5	2	
Palpation day 1	0	3 (7.5%)	2 (5.0%)	0 (0%)	0 (0%)	0 (0%)	5 (12.5%)
	0.5	0 (0%)	18 (45.0%)	3 (7.5%)	0 (0%)	0 (0%)	21 (52.5%)
	1	0 (0%)	2 (5.0%)	9 (22.5%)	0 (0%)	0 (0%)	11 (27.5%)
	1.5	0 (0%)	0 (0%)	0 (0%)	1 (2.5%)	0 (0%)	1 (2.5%)
	2	0 (0%)	0 (0%)	0 (0%)	1 (2.5%)	1 (2.5%)	2 (5%)
	Total	3 (7.5%)	22 (55%)	12 (30%)	2 (5%)	1 (2.5%)	40 (100%)

Values in the table are frequency and (% of total). On diagonal the shaded cells are the absolute agreement across the days.

Table 2Less experienced physiotherapist palpation intra-rater reliability across 2 days of measurements. $N = 40$.

Number of finger widths		Palpation day 2				Total
		0	0.5	1	1.5	
Palpation day 1	0	5 (12.5%)	1 (2.5%)	0 (0%)	0 (0%)	6 (15%)
	0.5	1 (2.5%)	16 (40.0%)	2 (4.2%)	0 (0%)	19 (47.5%)
	1	0 (0%)	5 (12.5%)	7 (17.5%)	0 (0%)	12 (30%)
	1.5	0 (0%)	0 (0%)	2 (5%)	1 (2.5%)	3 (7.5%)
	Total	6 (15%)	22 (55%)	11 (27.5%)	1 (2.5%)	40 (100%)

Values in the table are frequency and (% of total). On diagonal the shaded cells are the absolute agreement across the days.

Table 3

Palpation inter-rater reliability between the experienced and the less experienced physiotherapist. $N = 40$.

	Number of finger widths	Palpation from less experienced PT					Total
		0	0.5	1	1.5	2	
Palpation from experienced PT	0	3 (7.5%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (7.5%)
	0.5	2 (5%)	14 (35%)	4 (10%)	0 (0%)	0 (0%)	20 (50%)
	1	0 (0%)	4 (10%)	8 (20%)	2 (5%)	0 (0%)	14 (35%)
	1.5	0 (0%)	0 (0%)	1 (2.5%)	0 (0%)	0 (0%)	1 (2.5%)
	2	0 (0%)	0 (0%)	1 (2.5%)	1 (2.5%)	0 (0%)	2 (5%)
	Total	5 (12.5%)	18 (45%)	14 (35%)	3 (7.5%)	0 (0%)	40 (100%)

Values in the table are frequency and (% of total). On diagonal the shading cells are absolute agreement between the two PTs.

Table 4

IRD measured by ultrasound for each palpation category.

Palpation categories (finger widths)	N		Mean		95% CI	
	ME	LE	ME	LE	ME	LE
0	3	5	8.07	5.84	-8.64, 24.78	-1.19, 12.87
0.5	20	18	11.63	10.95	8.17, 15.09	8.01, 13.88
1	14	14	17.08	16.98	12.47, 21.68	12.81, 21.15
1.5	1	3	8.85	23.19	-	8.03, 38.35
2	2	-	14.38	-	-20.60, 49.36	-

Values in the table are mean IRD (mm) with 95% CI in the five categories assessed by palpation.

N , number of cases. ME, more experienced PT. LE, less experienced PT.