



Pregnancy-Related Diastasis Rectus Abdominis: Bridging the Research Practice Gap

*Sinéad Dufour PT PhD
Director of Pelvic Health
World of my Baby
Associate Clinical Professor
McMaster University*



thewomb.ca



Outline

- What is DRA?
- Structure and function: Canister Theory
- Critical appraisal of the literature
 - Gaps Analysis
 - Assessment Concepts
 - Management Concept
- Future Directions
- Discussion (Q&A)

DRA – Defined

- A condition in which the rectus abdominis muscle separates in the midline at the linea alba.
(Boissonnault, 1987)
- A condition concerning laxity of the linea alba.
(Akram 2014)
- A condition characterized by a gradual thinning and widening of the linea alba.
(Brauman 2008)


DRA – Defined

- Consensus that IRD is important.
- No consensus on many aspects of IRD:
 - where to measure along the linea alba?
 - cut off point for diastasis (pathology)?
 - What is NORMAL or representative of health and function?
 - Usually < "two finger widths". (Mota 2017)
- Consensus among Canadian experts that assessing IRD **alone** is **not** clinically meaningful. (Dufour 2019)

DRA Considerations


- Is it appropriate to ascribe the label of DRA in pregnancy?
- Can DRA be prevented?
- Have risk/prognostic factors been established?




 fertility • pregnancy • parenting • education
 theworldofmybaby.ca


Considerations - triggers for DRA?

Five Exercises That Cause DIASTASIS RECTI During Pregnancy
Diary of a Fit Mommy



All Planks
 Push Ups
 Quadruped Positions
 Twisting Movements
 All Crunches

thewomb.ca 7


 fertility • pregnancy • parenting • education
 theworldofmybaby.ca

DRA Considerations

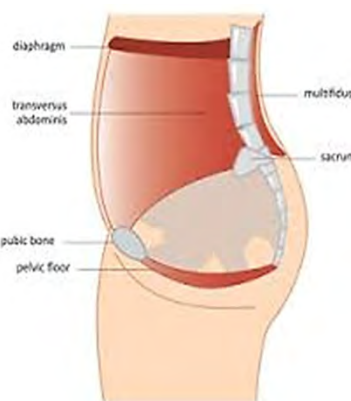
- DRA is prevalent and it is an issue at the top of mind for many – both those seeking and providing care.
- What is the state of the science?
 - How are we approaching DRA?
 - What do we know about assessment?
 - What do we know about management?
- How can we best address the research-practice gap?

thewomb.ca 8

Linea Alba and the Canister- Theory

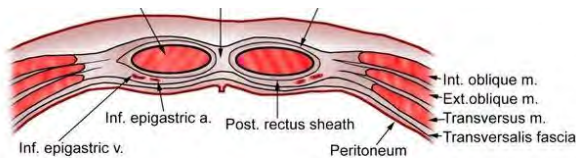
Hypothesis:

- A disorder in one component of the canister is associated with the development of a condition in another component. (Smith 2013)

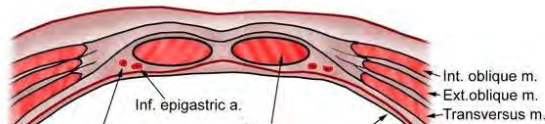


Linea Alba and the Canister- Theory

- Before inserting into the linea alba, the aponeuroses of the abdominal muscles come together to surround the rectus muscles.
- anterior & posterior layers above
- anterior only below



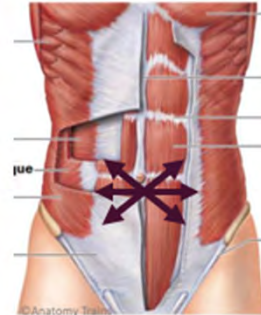
Below Arcuate Line



Linea Alba and the Canister- Theory

Linea alba = stiffest structure of the abdominal wall and the most important contributor to the mechanical stability of the abdominal wall.

(Hernandez-Gascon 2016)



Linea Alba and the Canister- Theory

In men and nulliparous women, inter-recti distance does not change during a sit-up.


(Chiarello 2016, Lee 2015)



Is the function of the canister impaired if the linea alba gets thinner and larger such as during and after pregnancy?



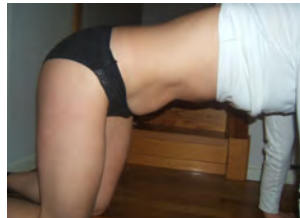
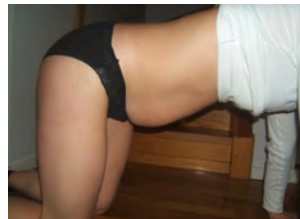
Linea Alba and the Canister- Theory

- A larger linea alba appears to “distort” more during effort. (Hills 2018) 
- IRD was found negatively correlated to trunk flexors and rotators strength and endurance after birth and at 6 months post-partum. (Liaw, 2011)
- IRD was found negatively correlated to trunk rotation torque and ability to perform a sit-up. (Hills, 2018)

thewomb.ca



- TA contraction **widens** IRD (Mota 2012; Sancho 2015; Mota 2015; Lee & Hodges 2017; Theodorsen 2017)
- PFM contraction **widens** the IRD (Theodorsen, 2017; Lee & Hodges, 2017)
- Sit up/curl up **narrows** IRD (Mota 2012; Sancho 2015; Pascoal 2014; Chiarello 2016; Lee & Hodges 2017).
- Implications?

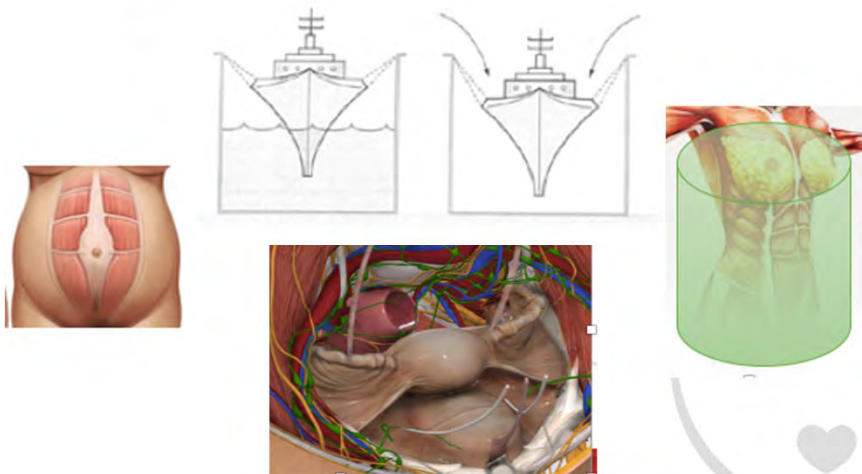


thewomb.ca

Linea Alba, Canister Theory & Pregnancy

- Do we have evidence that pregnancy-related changes (anterior aspect of the canister) lead to impairment and symptoms in other compartments of the canister (low back pain, pelvic pain, incontinence, etc...)?

Canister Theory





Linea Alba, Canister Theory & Pregnancy

- Prospective study N=300 first time pregnant women.
 - No difference in pelvic floor muscle strength & endurance at 6 weeks, 6 months and 12 months between women with and without diastasis. (Sperstad & Bø 2016; da Mota 2015).
- No greater IRD in women with and without back or pelvic girdle pain. (Chiarello 2017).

thewomb.ca



Linea Alba, Canister Theory & Pregnancy

- IRD does not appear to correlate with pregnancy-related PGP.
- DRA (as defined by IRD) has recently been correlated with POP. (Benjamin 2018)
- What about other aspects of the LA?
 - Implications?

thewomb.ca



Linea Alba, Canister Theory & Pregnancy


- Prevention and management of DRA in pregnancy?
 - No RCTs
 - One retrospective study (Chiarello 2005)
 - One consensus study (Dufour 2018)

thewomb.ca




*what do efficacy studies
say?*

thewomb.ca



RCT DRA Walton et al, 2016

- 9 women with either vaginal birth or CS
- Randomized to 3 visits/week for 6 weeks (3x10 reps + progression during period)
 - Plank OR
 - Modified sit up
 - In addition; Both groups had pelvic tilt, PFMT, obliques, external support
- Results (ultrasound and caliper)
 - Sig reduction in both groups (only at navel)
 - No diff between groups

thewomb.ca


RCT DRA Gluppe et al, 2018

- Control: usual care
- 4 month group training once a week
 - Strength training:
 - 5 sets of PFM exercises in different positions
 - 3 sets of abdominal exercises
 - 3 sets of back exercises
 - Strength training of arms and legs
 - Stretching of shoulder and neck
 - Total body relaxation
 - Home PFMT: 3 sets of 8-12 contractions/ day



	6 weeks pp	6 months pp	12 months pp	
Training group	48 (55.2%)	38 (43.7%)	36 (41.4%)	p<.01
Control group	48 (54.5%)	39 (44.3%)	35 (39.8%)	p<.01

No statistically significant difference between groups at any time

thewomb.ca



Evidence Summary

Systematic Review DRA (PP) Benjamin et al 2014

- 8 studies; 1 RCT
- Poor quality

“Based on the available evidence and quality of this evidence, non-specific exercise may or may not help to prevent or reduce diastasis of the rectus abdominal muscles during the ante and postnatal periods”

- 5 new RCTs = no change in this statement
- Urgent need to bridge the research practice gap
 - Highlights the important role of practice-based research!

thewomb.ca



ScienceNordic

About ScienceNordic
中文

Search:

Health Society & Culture Environment Technology Agriculture & Fisheries Natural Sciences Blogs

RESEARCH & STUDY

Researchers have no idea how to fix your 'mummy tummy'

April 15, 2018 - 06:20

For years, researchers have promoted treating separated abdominal muscles, called diastasis recti abdominis, with specific exercises. A new study shows this approach doesn't really work.

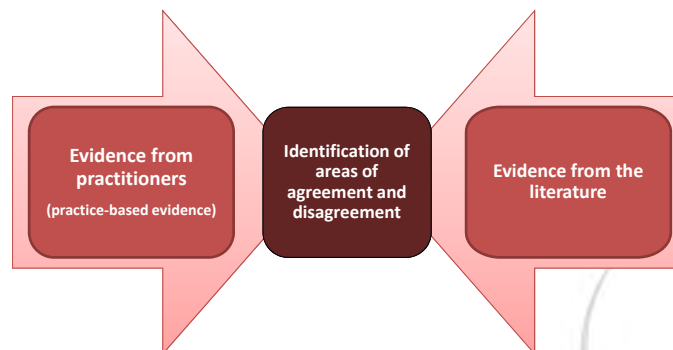
“Several studies have shown that the transverse abdominal muscle is activated when we exercise the pelvic floor muscles, and our starting point was that the stomach exercises would work on the diastasis, but they did not. The gap was not affected by pelvic floor training or stomach muscle exercises,” she said.

thewomb.ca

BUT....(Critical Appraisal)

- Heterogeneity across trials
- Focus on "what" exercises – not "how" or "when"
 - IAP management likely important
 - Critical healing period likely distinct
 - **CERT exercise intervention criteria***
- No attention to lifestyle and behaviours
 - Consider comparison to POP (Hagen 2017)
- Limited to IRD as the sole defining characteristic
- What about other potential influencing features?

Bridging the Gap





Practice-Based Research

Scientific research methods can be used to report on knowledge from knowledge users:

- 1. Survey** (Keeler et al 2012)
- 2. Delphi Consensus** (Dufour et al 2019)

thewomb.ca



Journal of
Women's Health
Physical Therapy

Diastasis Recti Abdominis: A Survey of Women's Health Specialists for Current Physical Therapy Clinical Practice for Postpartum Women


Keeler, Jessica DPT¹; Albrecht, Melissa DPT¹; Eberhardt, Lauren DPT¹; Horn, Laura MPT²; Donnelly, Chantal MPT²; Lowe, Deborah PT, PhD²

Journal of Women's Health Physical Therapy: September/December 2012 - Volume 36 - Issue 3 - p 131-142

doi: 10.1097/JWH.0b013e318276f35f

Research Reports

thewomb.ca



the world of my baby
fertility • pregnancy • parenting • education
thewomb.ca

Journal of
Women's Health
Physical Therapy

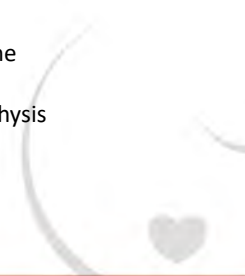
- Questionnaire to 2200 members of APTA Women's health (13.5% response rate)
- Treatment
 - Average visits/week: 1.6
 - Duration: 4-6 weeks
 - Reported success rate: ***41-100%**
- Intervention
 - 89% TrA training
 - 83% TrA + functional
 - 63% "Noble technique"
 - 87% pelvic floor muscle training
 - 81% therapeutic modalities
 - 59% manual therapy

Manual therapy = 59%

- Myofascial release: 46%
- Triggerpoint release: 36%
- Muscle energy technique: 33%
- Visceral manipulation: 21%

Other: "Joint mobilization":

- Sacrum
- Innominate
- Lumbar spine
- Coccyx
- Pelvic symphysis



thewomb.ca



the world of my baby
fertility • pregnancy • parenting • education
thewomb.ca

Journal of
Women's Health
Physical Therapy



Research Report

Establishing Expert-Based Recommendations for the Conservative Management of Pregnancy-Related Diastasis Rectus Abdominis: A Delphi Consensus Study

Sinéad Dufour, PT, PhD¹
 Stéphanie Bernard, PT, MSc²
 Beth Murray-Davis, PhD, RM³
 Nadine Graham, PT, MSc¹



McMaster University




MACPHERSON INSTITUTE



UNIVERSITÉ LAVAL



thewomb.ca



Assessment – Integrity of of LA

- Qualitative assessment of linea alba integrity
- Use the top of the LA as a reference
- Quantify the qualitative assessment of the integrity (fascial stiffness) through the LA on a five point likert scale
- Measurement taken at umbilicus, 2cm above and 2 cm below

The degree of integrity (fascial stiffness) equals that of the reference point (Dufour et al, 2019)

Stongly agree 4/4


Agree 3/4

Neutral 2/4

Disagree 1/4

Strongly disagree 0/4

thewomb.ca



Assessment – Tension Generation of of LA

- Qualitative assessment of linea alba integrity
- Use the top of the LA as a reference
- Quantify the qualitative assessment of the musclar tension generated through the LA with a voluntary pelvic floor contraction on a five point likert scale
- Measurement taken at umbilicus, 2cm above and 2 cm below

The degree of tendion generated equals that of the reference point (Dufour et al, 2019)

Stongly agree 4/4

Agree 3/4

Neutral 2/4

Disagree 1/4

Strongly disagree 0/4

thewomb.ca

Dynamic Assessment of IAP Management



Management during pregnancy...

- ✓ Encourage physical activity and movement patterns that do not excessively maintain high IAP to avoid persistent postpartum DRA.
- ✓ Encourage inner unit exercises to optimize postpartum recovery for DRA.



Management early postpartum...

- ✓ Encourage inner unit exercises very early after birth (within 24h).
- ✓ Encourage abdominal exercises to enhance trunk flexor and rotator muscles strength.
 - ✓ may not directly affect DRA, but important for trunk function.



Management late postpartum...

- ✓ Encourage abdominal exercises to enhance trunk flexor and rotator muscles strength.
- ✓ Avoid invagination or doming of the linea alba during exercises.
- ✓ Manual therapy strategies to address scar tissue and thorax mobility


 the world of my baby
 fertility • pregnancy • parenting • education
 thewomb.ca

Management

Scientific Literature

- Exercise





+

Experts

- Exercise
- Thoracic Mobility
- Lifestyle Management

= a more comprehensive and functionally relevant management approach

thewomb.ca


 the world of my baby
 fertility • pregnancy • parenting • education
 thewomb.ca

Lifestyle Management

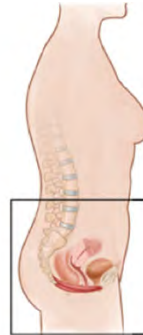
- Involves the counseling related to the evidence-based use of lifestyle therapeutic approaches that include diet, physical activity, sleep, and stress management (Bo et al, 2016).
- How do we best implement lifestyle management (behaviour change)?
 - *Health Coaching via Motivational Interviewing!*

thewomb.ca



Lifestyle Management

- Posture & Breathing
 - Length tension relationship
 - Organ support and fascial connection
 - Diaphragm and PF – tango!
 - Deep core system - synergistic
 - Canister includes LA



thewomb.ca




Lifestyle Management


- Lifting and other ADLs
 - Avoid breath holding
 - Breath before and through tasks
 - Antony Lo, 2016; Julie Weibe 2017
 - Consider principles from ROST MOVES MAMA
 - Rosttherapy.com



thewomb.ca

 **MedCrave**
Step into the World of Research.

Obstetrics & Gynecology International Journal

Research Article Open Access 

Pregnancy-related diastasis rectus abdominis: Impact of a multi-component group-based intervention

Volume 10 Issue 2 - 2019

Abstract

Purpose: To explore the feasibility and effect on outcomes of a one-time multi-component group-based intervention among women with pregnancy-related diastasis rectus abdominis (DRA).

Methods: Women with clinically diagnosed DRA and minimum 8 weeks postpartum participated in a pre-post cohort pilot study. Subjects participated in a group workshop consisting of education and exercise prescription. They were assessed before the workshop and 8 weeks later with a booster session at 4 weeks. The following assessments were used: inter-recti distance (finger width), linea alba (LA) integrity, LA tension generating capacity, active straight leg raise (ASLR), Pelvic Floor Disability Index (PFDI-20), and global rating of change scale (GRC).

Results: Thirty participants were enrolled in this study and 16 completed both pre and post measurements (53.3%). Following intervention, all outcomes measures improved with statistically significant changes in IRD (finger width), LA integrity, and LA tension generation.

The average GRC score was 1.7. Issues with loss to follow up point to lack of feasibility of this intervention in its current format.

Conclusion: We found one-time multi-component group-based intervention improved pregnancy-related DRA outcomes. Future studies need to further explore the effect of the different components within this intervention, particularly behavioural strategies. Further, the benefit of applying self-management principles in DRA interventions as well as further investigating assessment techniques is also warranted.


Keywords: sdiastasis rectus abdominis, exercise, self-management, feasibility

Sinéad Dufour, Abby Hurd, Emma Lis, Jennifer Speckley, Anne Stotesbury, Ciara Wright
University McMaster University, Canada.

Correspondence: Dr. Sinéad Dufour, University McMaster University, 1400 Main St. W. Hamilton, Ontario, Canada, Email: sdufour@mcmaster.ca

Received: January 22, 2019 | Published: March 06, 2019

thewomb.ca

 **the world of my baby**
family • pregnancy • parenting • education
thewomb.ca

THE LANCET

Pelvic floor muscle training for secondary prevention of pelvic organ prolapse (PREVPROL): a multicentre randomised controlled trial

Suzanne Hagen, Cathryn Glazener, Doreen McClurg, Christine Macarthur, Andrew Elders, Peter Herbison, Don Wilson, Philip Tooze-Hobson, Christine Hemming, Jean Hay-Smith, Marissa Collins, Sylvia Dickson, Janet Logan

Procedures

Pelvic floor muscle training was delivered both as one-to-one sessions and in a class setting. Women were offered five appointments with a specialist women's health physiotherapist over 16 weeks (weeks 0, 2, 6, 11, and 16). The physiotherapist assessed pelvic floor muscles, taught correct exercise technique, prescribed an individualised home pelvic floor muscle training programme (three sets of exercises daily, completion of exercise diaries), provided a prolapse lifestyle advice leaflet (with a focus on weight loss, avoidance of heavy lifting, constipation, coughing, and high-impact exercise), and tailored lifestyle advice (phase one). Women in the intervention

thewomb.ca



Exercise Management

- Exercise is a form of activity that is usually performed on a repeated basis over a period of time with specific objectives related to different parameters of fitness (strength, endurance, motor control and flexibility) (Bo et al, 2016).
- How do we best implement exercise management?
 - *Individualized Exercise Prescription!*

thewomb.ca





Exercise Management

- Needs to be individually tailored
- Needs to be carried out such to adequately manage IAP
- Inner unit exercise – emphasize co-ordination and motor control.
- Functional outer unit and abdominal exercises
- No one size fits all
 - but some common culprits!



thewomb.ca

- Exercise needs to be individually tailored and carried out in order to adequately manage IAP.
- Consider general health status for training and success with tissue remodeling.
- Determine what exercises impact the tissues with as many variables removed as possible.


thewomb.ca



Is our lens Myopic?

- We still have not conferred the canister theory
 - We have not adequately teased out the “what”, “how” and “when” related to exercise prescription as congruent with this theory
- We have yet to evaluate behavioural aspects of care (lifestyle)
- We have yet to explore and consider immune and endocrine factors
 - Could we be missing the link as was the case for pregnancy-related PGP?


thewomb.ca



fertility • pregnancy • parenting • education
thewomb.ca

Other Considerations

- Abdominal adhesions
- Immune and endocrine factors



ELSEVIER

Contents lists available at [ScienceDirect](#)

Annals of Medicine and Surgery

journal homepage: www.annalsjournal.com

Review

Abdominal adhesions: A practical review of an often overlooked entity

N. Tabibian ^a, E. Swehli ^a, A. Boyd ^a, A. Umbreen ^a, J.H. Tabibian ^{b, *}

^a Kaweah Delta Medical Center, Department of Family Medicine Residency Program, Visalia, CA, USA
^b UC Davis Medical Center, Division of Gastroenterology and Hepatology, Sacramento, CA, USA

thewomb.ca



fertility • pregnancy • parenting • education
thewomb.ca

New Research

- Stay tuned for research from Dr. Linda McLean and colleagues
- RCT – DRA Exercise Management: PI- K Bo (completion 2021)
- Scoping Review – DRA Assessment: PI- S Bernard (completion 2020)

thewomb.ca



Closing Remarks

- There is an important role for rehabilitation for pregnancy-related DRA
- There might be a role for prevention
- PTs tend to frame DRA from the perspective of the canister theory
 - yet to be fully substantiated
 - potentially myopic
- No magic list of “best exercises”
 - Lots of contextual factors to consider

thewomb.ca



Thank You & Questions?

Dr. Sinéad Dufour
Director of Pelvic Health
The World of my Baby (WOMB)
Assistant Clinical Professor
McMaster University
sdufour@mcmaster.ca



thewomb.ca

References

- Akram, J. and S. H. Matzen (2014). "Rectus abdominis diastasis." *J Plast Surg Hand Surg* **48**(3): 163-169.
- Armbruster, M., L. Brown, S. Butler, M. Lerner and S. J. Madill (2015). The Relationship Between Lumbar Lordosis and Stress Urinary Incontinence in Pregnant Women *Canadian Physiotherapy Association Annual Congress*. Halifax, University of Toronto Press. **67**: 1-68.
- Axer, H., D. G. von Keyserlingk and A. Prescher (2001). "Collagen fibers in linea alba and rectus sheaths." *J Surg Res* **96**(2): 239-245.
- Beer, G. M., A. Schuster, B. Seifert, M. Manestar, D. Mihic-Probst and S. A. Weber (2009). "The normal width of the linea alba in nulliparous women." *Clin Anat* **22**(6): 706-711.
- Betsch, M., R. Wehrle, L. Dor, W. Rapp, P. Jungbluth, M. Hakimi and M. Wild (2015). "Spinal posture and pelvic position during pregnancy: a prospective rasterstereographic pilot study." *Eur Spine J* **24**(6): 1282-1288.
- Bi, X., J. Zhao, L. Zhao, Z. Liu, J. Zhang, D. Sun, L. Song and Y. Xia (2013). "Pelvic floor muscle exercise for chronic low back pain." *J Int Med Res* **41**(1): 146-152.
- Bivia-Roig, G., J. F. Lison and D. Sanchez-Zuriaga (2018). "Changes in trunk posture and muscle responses in standing during pregnancy and postpartum." *PLoS One* **13**(3): e0194853.
- Blotta, R. M., S. d. S. Costa, E. N. Trindade, L. Meurer and M. R. Maciel-Trindade (2018). "Collagen I and III in women with diastasis recti." *Clinics* **73**: e319.

© 2018 BIA FORMATIONS INC. TOUS DROITS RÉSERVÉS.

References

- Brauman, D. (2008). "Diastasis recti: clinical anatomy." *Plast Reconstr Surg* **122**(5): 1564-1569.
- Capson, A. C., J. Nashed and L. McLean (2011). "The role of lumbopelvic posture in pelvic floor muscle activation in continent women." *J Electromyogr Kinesiol* **21**(1): 166-177.
- Chiarello, C. M. (2017). "Pregnancy-related pelvic girdle pain and diastasis rectus abdominis." *Journal of Women's Health Physical Therapy* **41**(1): 3-9.
- Chiarello, C. M., J. A. McAuley and E. H. Hartigan (2016). "Immediate Effect of Active Abdominal Contraction on Inter-recti Distance." *J Orthop Sports Phys Ther* **46**(3): 177-183.
- Chiarello, C. M., J. A. Zellers and F. M. Sage-King (2012). "Predictors of inter-recti distance in cadavers." *Journal of Women's Health Physical Therapy* **36**(3): 125-130.
- Coldron, V., M. J. Stokes, D. J. Newham and K. Cook (2008). "Postpartum characteristics of rectus abdominis on ultrasound imaging." *Man Ther* **13**(2): 112-121.
- Deeken, C. R. and S. P. Lake (2017). "Mechanical properties of the abdominal wall and biomaterials utilized for hernia repair." *J Mech Behav Biomed Mater* **74**: 411-427.
- Fernandes da Mota, P. G., A. G. Pascoal, A. I. Carita and K. Bo (2015). "Prevalence and risk factors of diastasis recti abdominis from late pregnancy to 6 months postpartum, and relationship with lumbo-pelvic pain." *Man Ther* **20**(1): 200-205.

© 2018 BIA FORMATIONS INC. TOUS DROITS RÉSERVÉS.

References

- Gillard, S., C. Ryan, M. Stokes, M. Warner and J. Dixon (2018). "Effects of posture and anatomical location on inter-recti distance measured using ultrasound imaging in parous women." *Musculoskeletal Science and Practice* **34**: 1-7.
- Gilleard, W. L. and J. M. Brown (1996). "Structure and function of the abdominal muscles in primigravid subjects during pregnancy and the immediate postbirth period." *Phys Ther* **76**(7): 750-762.
- Grassel, D., A. Prescher, S. Fitzek, D. G. Keyserlingk and H. Axer (2005). "Anisotropy of human linea alba: a biomechanical study." *J Surg Res* **124**(1): 118-125.
- Hodges, P. W. (1999). "Is there a role for transversus abdominis in lumbo-pelvic stability?" *Man Ther* **4**(2): 74-86.
- Hodges, P. W., R. Sapsford and L. H. Pengel (2007). "Postural and respiratory functions of the pelvic floor muscles." *NeuroUrol Urodyn* **26**(3): 362-371.
- Hollinsky, C. and S. Sandberg (2007). "Measurement of the tensile strength of the ventral abdominal wall in comparison with scar tissue." *Clinical Biomechanics* **22**(1): 88-92.
- Lee, D. and P. W. Hodges (2016). "Behavior of the Linea Alba During a Curl-up Task in Diastasis Rectus Abdominis: An Observational Study." *J Orthop Sports Phys Ther* **46**(7): 580-589.
- Mommers, E. H. H., J. E. H. Ponten, A. K. Al Omar, T. S. de Vries Reilingh, N. D. Bouvy and S. W. Nienhuijs (2017). "The general surgeon's perspective of rectus diastasis. A systematic review of treatment options." *Surg Endosc* **31**(12): 4934-4949.

© 2018 BIA FORMATIONS INC. TOUS DROITS RÉSERVÉS.

References

- Morkved, S., K. A. Salvesen, K. Bo and S. Eik-Nes (2004). "Pelvic floor muscle strength and thickness in continent and incontinent nulliparous pregnant women." *Int Urogynecol J Pelvic Floor Dysfunct* **15**(6): 384-389; discussion 390.
- Mota, P., A. Pascoal and K. Bø (2015). *Diastasis Recti Abdominis in Pregnancy and Postpartum Period. Risk Factors, Functional Implications and Resolution.*
- Mota, P., A. G. Pascoal, A. I. Carita and K. Bø (2018). "Normal width of the inter-recti distance in pregnant and postpartum primiparous women." *Musculoskelet Sci Pract* **35**: 34-37.
- Okanishi, N., N. Kito, M. Akiyama and M. Yamamoto (2012). "Spinal curvature and characteristics of postural change in pregnant women." *Acta Obstet Gynecol Scand* **91**(7): 856-861.
- Schröder, G., G. Kundt, M. Otte, D. Wendig and H.-C. Schöber (2016). "Impact of pregnancy on back pain and body posture in women." *Journal of Physical Therapy Science* **28**(4): 1199-1207.
- Smith, M. D., A. Russell and P. W. Hodges (2006). "Disorders of breathing and continence have a stronger association with back pain than obesity and physical activity." *Aust J Physiother* **52**(1): 11-16.
- Smith, M. D., A. Russell and P. W. Hodges (2014). "The relationship between incontinence, breathing disorders, gastrointestinal symptoms, and back pain in women: a longitudinal cohort study." *Clin J Pain* **30**(2): 162-167.

© 2018 BIA FORMATIONS INC. TOUS DROITS RÉSERVÉS.



References

- Sperstad, J. B., M. K. Tennfjord, G. Hilde, M. Ellstrom-Eng and K. Bo (2016). "Diastasis recti abdominis during pregnancy and 12 months after childbirth: prevalence, risk factors and report of lumbopelvic pain." *Br J Sports Med* **50**(17): 1092-1096.
- Stokes, I. A. F., M. G. Gardner-Morse and S. M. Henry (2011). "Abdominal muscle activation increases lumbar spinal stability: Analysis of contributions of different muscle groups." *Clinical Biomechanics* **26**(8): 797-803.
- van Veelen, G. A., K. J. Schweitzer and C. H. van der Vaart (2014). "Ultrasound imaging of the pelvic floor: changes in anatomy during and after first pregnancy." *Ultrasound Obstet Gynecol* **44**(4): 476-480.
- Vleeming, A., M. D. Schuenke, L. Danneels and F. H. Willard (2014). "The functional coupling of the deep abdominal and paraspinal muscles: the effects of simulated paraspinal muscle contraction on force transfer to the middle and posterior layer of the thoracolumbar fascia." *Journal of Anatomy* **225**(4): 447-462.
- Yoo, H., D. Shin and C. Song (2015). "Changes in the spinal curvature, degree of pain, balance ability, and gait ability according to pregnancy period in pregnant and nonpregnant women." *Journal of Physical Therapy Science* **27**(1): 279-284.

© 2018 BIA FORMATIONS INC. TOUS DROITS RÉSERVÉS.