

Case-Based Management of Musculoskeletal Dysfunction in the Obstetric client

Nebraska Physical Therapy Association
2018

Jill Schiff Boissonnault, PT, PhD, WCS

Objectives

Upon completion, participants should be able to:

1. Understand and apply to patient care the pathophysiology of various obstetric musculoskeletal disorders commonly seen in this population.
2. Practice and apply treatment interventions to the pregnant and postpartum client for these musculoskeletal dysfunctions.
3. Develop appropriate home programs for clients with such musculoskeletal dysfunction.
4. Appreciate current evidence for the interventions the participants discuss and practice

The Cases

- Pelvic Girdle Pain in Pregnancy
- Pregnant client with a Herniated Nucleus Pulposus (HNP)
- Pregnant client with Transient Osteoporosis of the Hip (TOH)
- Post-partum client with L&D-related coccydynia
- Diastasis Recti Abdominis-Current Evidence and Practice

The Format

- Expectation of Participation-bringing the wisdom in the room into the course!
- Weaving into the discussion:
 - Evidence
 - Examination concerns
 - Intervention options (exercise, manual therapy, belts/supports, advice)
 - Home programs

Case 1: Pregnant Woman with Pelvic Girdle (and Low Back) Pain



SoWH CPG on PGP

- Good resource for ICF codes
- Nice review of outcome measures for PGP
- Good review of tests and measures
- Generalized guide to choices for:
 - Examination techniques
 - Interventions
 - Risk factors

Clinton SC, Newell AM, Downey PA, Ferreira K. Pelvic Girdle Pain in the Antepartum Population: *Physical Therapy Clinical Practice Guidelines Linked to the International Classification of Functioning, Disability, and Health from the Section on Women's Health and the Orthopaedic Section of the American Physical Therapy Association.*
<http://www.womenshealthapta.org/practice/clinical-practice-guidelines/>

Epidemiology of Pelvic Girdle Pain in Pregnancy

Albert, 2002

1460 women who formed incidence cohort, assessed at 33 wks gestation

- Women who reported daily pain that could be objectively confirmed as PGP: 20.1%
- Sub-grouped as follows:
 - Pelvic girdle syndrome (pain in all 3 joints) (6.0%)
 - Symphysiolysis (2.3%)
 - One-sided a sacroiliac syndrome (5.5%)
 - Double-sided sacroiliac syndrome (6.3%)
 - Misc (sx not objectively confirmed)

Prevalence in India (N=580):

- Found to be higher: 75% in urban women, 25% in rural women.
- 3 classification groups:
 - posterior PP (65%),
 - LBP (31%),
 - Anterior PP (15%)

(Mahishale, 2016)

Risk Factors for PGP & LBP in Pregnancy

- Parity ↑ Odds Ratio of having PGP in pregnancy (Bjorland, 2010)
- ↑ risk PGP during the previous 4 weeks @ more advanced stage of pregnancy, ↑ BMI, & ↑ depression score. (Kavasi, 2012)
- PP: Breastfeeding found to slightly ↓ risk (Bjorland 2014)
- ↑ risk of disability and pain intensity @ 30 wks using multivariable model:
 - Self-reported pain locations in the pelvis
 - +(P4) test
 - Sum of pain provocation tests in early pregnancy
 - ↑ Distress

(Robinson 2010)

Owe 2016:

- 39,184 nulliparous women, enrolled in the Norwegian Mother and Child Cohort study
- Compared to non-exercisers, women exercising 3–5 times weekly pre-pregnancy had a 14% ↓ risk of PGP in pregnancy
- Taking part in high impact exercises such as (e.g., running, jogging, high-impact aerobics) ↓ risk of PGP

Risk Factors for PP PGP

- 283 women 12 wks pp who had been examined in wk 30 of pregnancy.
- Using a multivariable model, pre-pregnancy LBP and “sum of pain provocation tests” were significantly associated with PGP disability 12 wks pp. (excluding P4, which did not fall out as significant)
- Two 2-way interaction effects were significantly associated with long-term disability 15 months postpartum:
 - age & trunk flexor endurance
 - disability & hip extensor strength.

(Robinson 2010-b)

(Sjodahl 2013)

Prognosis for Obstetric Pelvic Girdle Pain

(Albert et al, 2001)

- Cohort of 1789 women initially assessed at 33 wks
- These women were re-examined (questionnaire and physical exam) at regular intervals for 2 years after delivery or until sx disappeared
- At 2 yr postpartum, 21% with pelvic girdle syndrome (pain in all 3 joints) still had pain
- Indicators of highest relative risk for long term pain
 - High number of positive tests
 - Low mobility index
- Conclusion: women with pelvic girdle syndrome or pain in all 3 joints, had poorest prognosis

Prognosis, Continued

- Presence of PGP @ 3 mos pp is poor prognosis for PP PGP @ 1 yr (Van De Pol 2007)
- ASLR test and 'belief in improvement' tested in early pp period, fell out in a multivariate analysis as predictors of having PGP 1-yr postpartum (Vollstad 2009)
- 99% of a PP cohort had PGP resolved by 12 wks pp, regardless of interventions (std. care plus acupuncture, std care plus stab ex, std care alone) (Elden 2008)

Medical Management of Pelvic Girdle Pain in Pregnancy

- Pain Medications
- Belts and Supports-off the shelf type
- Referral to PT

Patient Hx/Interview - PGP in Pregnancy

- Typical order of difficult ADLs for severe PGP listing most to least:
 - standing still,
 - cycling,
 - walking,
 - sitting,
 - and lying
- *Pelvic Girdle Pain Questionnaire:*
- Self-reported questionnaire that is condition specific for PGP utilizing 2 scales (activities/participation and symptoms); highly reliable and valid in women with PGP during and after pregnancy

(Ronchetti, 2008)

(Stuge, 2011)

Physical Exam Assessment- PGP in Pregnancy

- Severity of PGP assessed with specific tests
 - Posterior pelvic pain provocation test (P4/thigh thrust)
 - Functional pelvic test: Active straight leg raise test (ASLR)
 - Long dorsal ligament tests
 - Quebec Back Pain Disability Scale
- European Guidelines for PGP:
 - SIJ Pain:
 - Posterior pelvic pain provocation test (P4/thigh thrust)
 - Patrick's Faber test
 - Palpation of the long dorsal SIJ ligament
 - Gaenslen's test
 - Symphysis
 - Palpation of the symphysis
 - Modified Trendelenburg test of the pelvic girdle
 - Functional pelvic test: Active straight leg raise test (ASLR)

(Ronchetti, 2008)

(Vleeming, 2008)

Posterior Pelvic-Pain Provocation Test (P4)

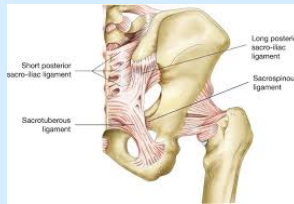
Use Hand or shoulder to direct force downwards toward the table. Have other hand cup the sacrum to assess movement along the joint line.



Active
Straight Leg
Raise Test-In
this Case, for
Pelvic girdle
Instability

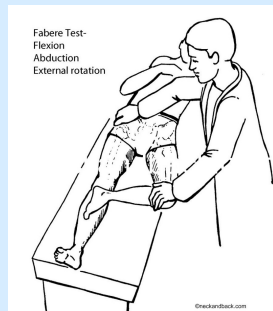


Palpation can be done
prone or in sidelying
**Long Dorsal Ligament
Palpation**



online library.wiley.com

Patrick FABER Test

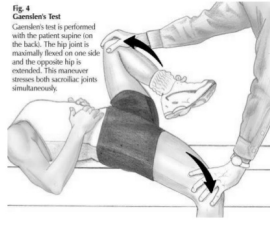


en.wikipedia.org

Gaenslen's Test

Gaenslen test stresses the sacroiliac joints. Increased pain during this test could be indicative of joint disease.

GAENSLEN TEST



www.slideshare.net

Pubis Palpation (or Springing) for Tenderness



Compression Test



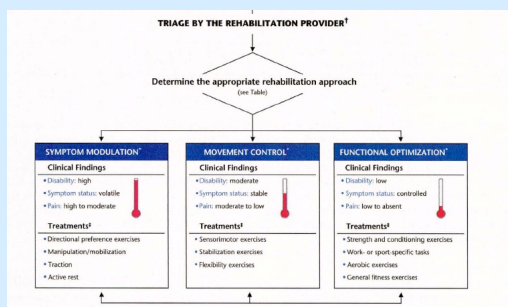
www.youtube.com

Distraction Test



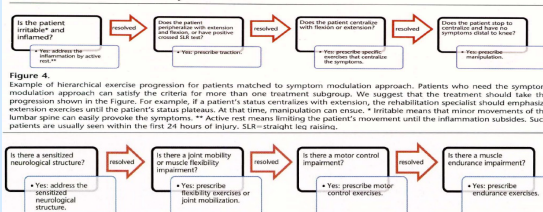
www.youtube.com

Treatment Based Classification: How to Apply to PGP/LBP in Pregnancy?



Treatment Based Classification: How to Apply to PGP/LBP in Pregnancy?

Treatment-Based Classification System for LBP



Alrway 2016, p.1064-5, Figure 4,5

Cochrane Review on Interventions for LB & PGP

(Liddle, Pennick 2015)

Low-back pain

- Combined 7 studies (645 women) exercise (lasting from 5-20 weeks) improved women's levels of low-back pain and disability.

Pelvic pain

- ↓ evidence on Rx for PGP
- 2 studies: women who participated in group exercise and received information about managing their pain reported no difference in PGP compared to women who received usual prenatal care.

Low-back and pelvic pain

- 4 studies combined (1176 women): 8-12-week exercise program reduced LB and PGP
- Land-based exercise ↓ LB/PGP-related sick leave in 2 studies (1062 women).
- However, 2 other studies (374 women): group ex + information was no better at preventing LB or PGP than usual prenatal care.
- There were a number of single studies that tested a variety of treatments.
 - Findings suggested that craniosacral therapy, osteomanipulative therapy or a multi-modal intervention (manual therapy, exercise and education) may be of benefit.

EBP for PT Interventions- PGP in Pregnancy

- Contraction of TRa ↓ laxity of SI-jt; drawing-in maneuver → ↓ laxity of SI-jt (Richardson, 2002)
- Systematic Reviews support use of exercise for treatment or prevention of PGP either alone or in combination with acupuncture, yoga, advice and/or belts (Belogolovsky 2015, Boissonnault 2012, Stuge 2003)
- Stabilization exercises/core work have received the most study and recognition

Exercise for Management of Pelvic Girdle Pain in OB

"The role of Exercise in Management of Pelvic Girdle and Low Back Pain in Pregnancy: A Systematic Review of the Literature." Boissonnault J, et al, 2012 (Table 2-next slide)

- Eleven studies were reviewed.
 - 3, good quality (range 7-8/10);
 - 6, moderate quality (range 4-6/10);
 - 2, poor quality (0-3/10).
- High-quality studies support the intervention of exercise
 - alone or combined with **advice** or other Rx (support belts, acupuncture)
 - Some supported ex as preventative; some supported ex for management of PGP and LBP.
- One study found acupuncture superior to exercise which was, in turn, more effective than "standard treatment". (Elden, et al)
- Addition of pelvic support belts to exercise intervention did not further decrease pain (Depledge et al)
- Utilization of sick leave conflicted across studies.

Author	Lighting Criteria specified	Position Allocation	Architectural Allocation	Design Section @ Baseline	Design Blending	Design Blending	Interior Blending	2D/3D Drawings	Architectural Visual Analysis	Architectural/Statistical Comparison	Point Metrics and Variability Data	Final Score
Wardner*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	92.50
Slater*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	90.50
Grashof**	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	92.50
Grashof**	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	92.50
Johnson**	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	91.50
Johnson**	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	91.50
Markus**	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	92.50
Johnson-Miksanek**	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	92.50
Johnson**	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	92.50
Slater**	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	91.50
Grashof**	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	92.50

PEDco Scoring for included articles. A point is awarded if the paper met the criteria. For PEDco discretion, the total score does not include the first row: "Flexibility criteria specified".

So What Are Our Exercise Options for PGP?

- Isolated activation of deep, local muscle system with integration into all transitional movements: abdominal drawing-in
- Spine stabilization exercises in various positions: sidelying, quadruped, Upright kneel
- Functional Lower extremity strengthening with equal-bilateral weight bearing: E.G., sit to stand, Rising and lowering to half-kneel
- Trunk/Pelvic girdle strengthening: anterior-posterior tilting standing, gluteus maximus, gluteus medius, back extensors
- Water-based exercise programs
- Fitness advice: which activities or machines?

Education for PGP

- To ↓ catastrophizing and fear beliefs
 - use of FABQ and other self-administered questionnaires can provide evidence for the intervention
 - To empower self-management of the condition
- Provide information on prognosis
 - Provide information on L & D positioning options
- 
- en.wikipedia.org



Advice for PGP

- Postural alignment
- Body mechanics
 - Sleeping/rest positions
 - Bed surface (soft!)
 - ADLs (e.g., laundry, grocery-shopping)
 - Child-care activities (including use of baby equipment)
- Symmetrical movement
 - Sit-to-stand
 - Bed mobility
- Isometric use of Adductors or Abductors in transitional activities (rolling, shifting)
- Use of heat/ice (ice, especially over symphysis pubis)



Manual Therapy Options for PGP



- Muscle Energy Rx
- Direct Jt-mob to Sacral bases, ILAs, L-S, T-S
- STM about posterior pelvis, adductors, trochanters

(Murphy 2009, Licciardone 2010, George 2012)

Osteopathic Biomechanics of the Pelvis (MET Rationale)

Mechanics

- Pubis: moves about a rotational axis
- Sacrum: Moves about a transverse axis (flexion and extension) & an oblique axis (forward and backward torsions)
- Ilium: Moves about a transverse axis (anterior and posterior rotation) and about a longitudinal axis (in-flare and out-flare)

Dysfunctions

- Pubis
 - Inferior shear and Superior shear
 - Separations in the frontal plane
- Sacrum
 - Sacral torsions (forward, e.g., L on L; and backward, e.g., L on R)
 - Unilateral sacral shears (unilateral sacral flexion or superior sacral shear; unilateral sacral extension or inferior sacral shear)
- Ilium
 - Iliac rotations
 - In-flares and out-flares
 - Upslips and Downslips

So what is A 'Muscle Energy' Technique?

- Contract-Relax at the barrier and then move further into the range

Or

- Use of a muscle as a prime mover to shift the bone at the joint

Or

- A "Shove" technique with some Contract-Relax used to let the motion occur

What's the evidence for MET?

Licciardone J, et al. Osteopathic manipulative treatment of back pain and related symptoms during pregnancy: a randomized controlled trial. Am J Obstet Gynecol 2010;202:43.e1-8.

- Compared usual OB care + OMT to usual OB care + sham US Rx, and usual OB care only. (N=144)
- Disability (per Roland-Morris Disability Q.) worsened in all groups as pregnancy progressed
 - Significantly less worsening in the OB care + OMT group
- Pain ↓ in OB care + OMT; unchanged in OB care + US group; ↑ in OB care only grp
- OMT = and of the following alone or in combination
 - Soft tissue mob
 - Myofascial release
 - MET and ROM mob
- Protocol included systematic CDM as to which was utilized
- No high-velocity thrust utilized

MET to Correct a Forward Sacral Torsion

1. Pt. L sidelying
2. Pt. turns to Left and reaches back to grasp table edge
3. Operator flexes LEs to approximately 90° hip flex.
4. Operator attempts to push B LEs down @ ankles while Pt. resists
5. Isometric hold for about 10 sec.
6. Operator takes up slack and pushes ankles downward, then Pt. resists again.
7. Repeat a few times.



Belts/Supports and Gait Aids

- Support garments for Pelvic Girdle Pain: some evidence for use
(Carr 2003, Mens 2006, Ho 2009)
- Consider assistive gait aid if gait continues to be aggravating
 - Forearm crutches
 - Rolling walker
 - scooter



Commence Dog and Pony Show!

PT Recommendations for L&D- PGP in Pregnancy

- First Stage
 - Minimize walking
 - Avoid asymmetric postures
- Second Stage
 - Support LE's, if semi-reclining, with pillows folded under knees
 - Avoid WB postures if these provoke Sx (e.g., 4-point, upright kneel)
 - Avoid squatting, especially if pain is @ pubis

(Boissonnault J., 2002)

Dysfunction	Positions to Avoid	Recommended Positions
Lumbar or Thoracic Disc Herniation or Bulge	-Squatting -Semi-reclining/knees to chest, -Lithotomy and hands/knees if nerve root tension is an issue	-Semi-reclining/lumbar support -Side lying -Hands/Knees if nerve root tension is not an issue
Intervertebral Spinal Stenosis	Standing	-Any position that opens the intervertebral foramen; side lying with side bending to the opposite side, with or without flexion -Positions that encourage spinal flex; squatting, forward bending over the a Swiss Ball, bean-bag chair or pillows
Spondylolisthesis	Standing	Any position that avoids increased lumbar spine extension
Sacroiliac Dysfunction	Walking during first stage Semi-reclining with LE's unsupported Lithotomy	-Any position where the LE's are symmetrically supported; semi-reclining with pillows under both knees -Hands/knees, upright kneel if WB OK
Pubic Symphysis Dysfunction	-Side lying if the LE's are widely abducted -Squatting -Lithotomy	-Side lying if the LE's are not widely abducted -Semi-reclining with knees supported by pillows -Hands/knees or upright kneel if weight bearing is comfortable
Coccyx Dysfunction	Semi-reclining Lithotomy	Any position where the coccyx is free to move: Side lying, Squatting, Hands/knees, Upright Kneel Standing

Table 1 Summary of Position Modifications for Women with Pre-existing Spinal or Pelvic Ring Dysfunction

The Case

- 30 yr old Gravida 2, para 1, @ 14 weeks gestation. Has a 3-yr old dtr., and is a University professor
- CC: Left SI-jt pain, with occasional pubic pain and Right SI-jt pain
- Hx of CC: Began @ 8 weeks and has worsened. Has similar pain (less intense) in first pregnancy that abated between pregnancies.
- Pt. Goals: To continue working and exercising as she does now.

Findings of Pt. Interview: PGP

- Rates pain 2/10-7/10
- Location: "my left rear-end dimple, sometimes the same place on the right; when it's bad, my left upper thigh and buttock; and after a really long day with lots of time on my feet-my groin aches too"
- Nature: Can be sharp (intermittent) or achy (can be constant once it comes on).
- Agg: climbing hill from parking ramp to office, rolling over in bed, walking > 10 min, sit-to-stand after sitting > 45 min
- Alev: NWB rest, ice, Tylenol

Physical Exam Findings in PGP Case

- Gait: avoiding full WB Left
- Standing posture: avoiding full WB Left
- Position testing in sitting: Left on Left Sacral torsion
- Palpation: painful at Left and Right SI jts over sacral sulci; some tenderness at pubis. Left dorsal ligament painful
- ASLR and P4+ on the left; weight shift onto L LE provokes her sharp L-sided pain

PT Interventions for PGP Case

- MET to correct sacral torsion with HEP; Direct mobilization in sitting @ Left ILA
- Exercise
 - Stabilization: trunk ex in 4 point
 - Strengthening ex: standing pelvic tilts, TRa in 4-point & sitting, glut medius strengthening with theraband, glut max strengthening in 4-point
- Body mechanics instruction
 - Sleep: get soft mattress pad and squeeze pillow between legs to roll and shift
 - Lifting 3-yr old
- Postural alignment
 - Sleep with pillow between knees and avoid asymmetric sleeping postures
 - Sitting @ desk: avoid crossing LE's; got her a foot rest and a work chair back support



Sacral torsion
Self-
Mobilization
HEP

Transverse Abdominis Ex in 4-Point



Transversus
Abdominis
Exercise While
Sitting
or When Driving



Posterior Pelvic Tilt on the
Wall



Gluteus Maximus
Strengthening



Gluteus Maximus Strengthening in 4-Point



Pelvic Stabilization Via Adductor Squeeze to Assist in ↓ Pain with Rolling



PT Interventions for PGP Case, cont.

- Symmetrical movement instruction
 - Sit-to-stand: symmetry and/or with isometric abduction
- Ice to SI-jts and/or pubis at home, prn
- SI-belt: Found it helpful if doing chores requiring WB > 15 min. Preferred Serola Belt (Serola.net)
- Discussed fitness program: encouraged her to move to aqua class/exercise vs. land-based running and Zumba classes.
- Self-mobilization for SI-Jt pain (seated and standing)
(Lets practice this!)

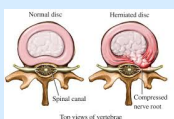
Pelvic Girdle Pain in Pregnancy References

- Albert H, Godskesen M, Westergaard J. Prognosis in four syndromes of pregnancy-related pelvic pain. *Acta Obstet Gynecol Scand*. 2001;80(6):505-10.
- Albert HB, Godskesen M, Westergaard JG. Incidence of four syndromes of pregnancy related pelvic joint pain. *Spine*. 2002; 27(24):2831-4.
- Alrwaily M, Timko M, Schneider M, Stevens J, Bise C, Hariharan K, Delitto A. Treatment-based classification system for low back pain: revision and update. *Phys Ther*. 2001;81(7):1057-1066.
- Belogloukly I, Katzman W, Christopherson N, Rivera M, Allen DD. The Effectiveness of Exercise in Treatment of Pregnancy-Related Lumbar and Pelvic Girdle Pain: A Meta-Analysis and Evidence-Based Review. *J of WomHealth PT*. 2015;39 (2):53-64.
- Bjelland EK, Askild A, Johansen R, Eberhard-Gran M. Pelvic girdle pain in pregnancy: the impact of parity. *Am J of Obstet Gynecol*. 2010;203:146.e1-6.
- Boissonnault JS, Klestinski JU, Peary K. The role of exercise in the management of pelvic girdle and low back pain in pregnancy: a systematic review of the literature. *J of WomHealth PT*. 2012;36(2):69-77.
- Carr CA (2003) Use of a maternity support binder for relief of pregnancy-related back pain. *Journal of Obstetric, Gynecologic, and Neonatal Nursing* 32, 495-502.
- Clinton SC, Newell AM, Downey PA, Ferreira K. Pelvic Girdle Pain in the Antepartum Population: *Physical Therapy Clinical Practice Guidelines Linked to the International Classification of Functioning, Disability, and Health from the Section on Women's Health and the Orthopaedic Section of the American Physical Therapy Association*. 2017; 41(2) p. 109-125.
- DeStefano L, Greenman P. *Greenman's principles of manual medicine*. Baltimore, MD : Lippincott Williams & Wilkins/Wolters Kluwer, 2011.
- Eiden H, et al. Regression of pelvic girdle pain after delivery: follow-up of a randomised single blind controlled trial with different treatment modalities. *Acta Obstetrica et Gynecologica*. 2008; 87: 201208.
- George JW, Skaggs CD, Thompson PA, Nelson DM, Gavard JA, Gross GA. A randomized controlled trial comparing a multimodal intervention and standard obstetrics care for low back and pelvic pain in pregnancy. *Am J Obstet Gynecol*. 2012 Oct 23. pii: S0002-9378(12)00969-2. doi: 10.1016/j.ajog.2012.10.869. [Epub ahead of print].
- Ho SS, Yu WW, Lao TT, Chow DH, Chung JW, Li Y. Effectiveness of maternity support belts in reducing low back pain during pregnancy: a review. *J Clin Nurs*. 2009 Jun;18(11):1523-32.
- Kovacs et al. Prevalence and Factors Associated With Low Back Pain and Pelvic Girdle Pain During Pregnancy. *SPINE Volume 37, Number 17, pp 1516-1533*.
- Liccardone JC, Buchanan S, Hensel K, King HH, Fulda KG, Stoll ST. Osteopathic manipulative treatment of back pain and related symptoms during pregnancy: a randomized controlled trial. *Am J Obstet Gynecol* 2010. 202.43.e1-8.
- Liddle SD, Pennick V. Interventions for preventing and treating low-back and pelvic pain during pregnancy. *Cochrane Database of Systematic Reviews* 2015, Issue 9. Art. No.: CD001139. DOI: 10.1002/14651858.CD001139.pub4

Pelvic Girdle Pain in Pregnancy References, cont.

- Mens, J.M.A., Vleeming, A., Snijders, C.J., Stam, H.J., Ginal, A.Z., 1999. The active straight leg raising test and mobility of the pelvic joints. *Eur Spine J* 8, 468-475.
- Mens JM, Damen L, Snijders CJ, Stam HJ. The mechanical effect of a pelvic belt in patients with pregnancy-related pelvic pain. *Clin Biomech* 2006;21:122-7.
- Murphy DR, Harwitz EL, McGovern EE. Outcome of pregnancy-related lumbopelvic pain treated according to a diagnosis-based decision rule: a prospective observational cohort study. *J Manipulative Physiol Ther* 2009;32:616-24.
- Owe KM, Bjelland EK, Stuge B, et al. Exercise level before pregnancy and engaging in high-impact sports reduce the risk of pelvic girdle pain: a population-based cohort study of 39 184 women. *Br J Sports Med* 2016;50:817-822.
- Robinson et al. Pelvic girdle pain - associations between risk factors in early pregnancy and disability or pain intensity in late pregnancy: a prospective cohort study. *BMC Musculoskeletal Disorders* 2010, 11:91 <http://www.biomedcentral.com/1471-2474/11/91>
- Robinson et al. Pelvic girdle pain: Potential risk factors in pregnancy in relation to disability and pain intensity three months postpartum. *Manual Therapy*. 2010;15(6):522-528.
- Ronchetti I, Vleeming A, van Wingerden JP. Physical characteristics of women with severe pelvic girdle pain after pregnancy: a descriptive cohort study. *Spine*. 2008 Mar 15;33(5):E45-S1.
- Richardson CA, Snijders CJ, Hides JA, Damen L, Pas MS, Storm J. The relation between the transversus abdominis muscles, sacroiliac joint mechanics, and low back pain. *Spine*. 2002 Feb 15;27(4):399-405.
- Sjodahl J, Gurtke A, Oberg B. Predictors for long-term disability in women with persistent postpartum pelvic girdle pain. *Eur Spine J* (2013) 22:1665-1673.
- Stuge B, Hilde G, Vollestad N. Physical therapy for pregnancy-related low back and pelvic pain: a systematic review. *Acta Obstet Gynecol Scand*. 2003;82:983-990.
- Stuge B, Bergland A. Evidence and individualization: important elements in treatment for women with postpartum pelvic girdle pain. *Physiother Theory and Practice*. 2011;27(8):557-565.
- Stuge B, Garratt A, Kroghstad Jensen H, Grotle M. The pelvic girdle questionnaire: a condition specific instrument for assessing activity limitations and symptoms in people with pelvic girdle pain. *Phys Ther*. 2011;91:1096-1108.
- Van De Pol G, et al. Pregnancy-related pelvic girdle pain in the Netherlands. *Acta Obstetrica et Gynecologica*. 2007; 86: 416-422.
- Vleeming A, Albert HB, Ostgaard HC, Sturesson B, Stuge B. European guidelines for the diagnosis and treatment of pelvic girdle pain. *Eur Spine J*. 2008;17:794-819.
- Vollestad N, Stuge B. Prognostic factors for recovery from postpartum pelvic girdle pain. *Eur Spine J* (2009) 18:718-726.

Herniated Nucleus Pulposus in Pregnancy



www.backpainhelptoday.com



Epidemiology-HNP in Pregnancy

- 1/10,000 De Novo disc herniations in pregnancy (Laban MM, Viola S, Williams DA, Wang A. Magnetic resonance imaging of the lumbar herniated disc in pregnancy. Am J Phys Med Rehabil, 1995; 74[1]: 59-61.)
- Much more common to see women with previous Hx of HNP who are now pregnant

Medical Management-HNP in Pregnancy

- MRI safe in pregnancy as a means of Dx of HNP (Laban 1995, Laban 1995, Weinreb 1989)
- Opioids sometimes given as pain relief (Matsumoto 2009)
- Surgery is an option (Brown and Levi, 2001)
- Mode of Delivery: C-Section vs. Vaginal
- Cases of Cauda Equina (Timothy 1999, Askan 1998, Chow 2008., Gupta 2008.)

Review of Osteopathic Mechanics

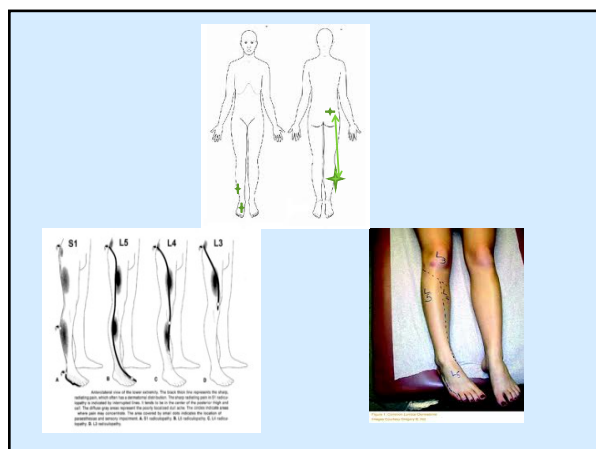
- Fryette's laws on neutral and non-neutral mechanics
- Type 1 and Type 2 lesions
- FRS and ERS
- Sacral Torsions
- Pubic Shears
- Response of the sacrum to Lumbar spine motion

HNP in Pregnancy-the Case

- A 30-year-old G2P1 woman presented at 22 weeks gestation with complaints of right buttock and lower extremity pain.
- Mechanism of Injury (MOI): lifting 2-year old from floor to changing table.
- Previous Medical Hx: Mild backache in previous pregnancy
- Physical examination:
 - left lateral shift
 - flattened lumbar lordosis
 - positive right straight leg raising at 30 °
 - positive crossed straight leg raising at 45 °
- MRI: moderate right posterolateral disk protrusion at the L4-5 level with probable compromise of the L5 nerve root.

HNP in Pregnancy Patient Interview Findings

- CC: Sharp, intermittent R LE pain and P/N and mild-moderate LBP. No c/o bowel/bladder dysfunction
- MOI: lifting her 2-yr old from floor
- Hx: No c/o LE pain in 1st pregnancy. Had mild-moderate LBP in this pregnancy prior to onset of LE pain. No previous LB or LE pain outside of pregnancies
- Location: R lateral calf and dorsal aspects of R foot.
- Aggravation: FB, sitting > 15 min, childcare, lifting
- Alleviation: supine lying
- Nature: Sharp, some P/N when aggravated. Intermittent. Ranges from 3-8 on 0-10 pain scale



HNP in Pregnancy Physical Examination Findings

- Left lateral shift
- Flattened lumbar lordosis
- Neuro exam:
 - Positive right straight leg raising at 30
 - Positive crossed straight leg raising at 45 °
 - Diminished sensation R LE in L5 distribution
 - DTR's WNL
- Increased T-S kyphosis , mildly increased C-S lordosis
- Forward head posture
- Flat feet with mild pronation bilaterally

HNP in Pregnancy Physical Examination Findings-cont.

- Restricted segmental mobility L5 into L SB/ROT/BB (FRS R L5)
- PA pressure at L5 restricted and painful, Gr II
- Increased paraspinal tone L low lumbar
- Leg Sx worsened with FB; slightly minimized with repeated BB
- Shift correction → ↑LB pain, but ↓ LE Sx
- Provocation tests for PGP negative
- Gait is unremarkable, though slow

HNP in Pregnancy PT Interventions

- Manual Left Lateral Shift correction
- Self-Correction of lateral shift
- BB exercises: 4-point; standing, leaning against wall (with lateral shift correction); standing, leaning on table
- Traction: in pool; holding onto doorframe (with lateral shift correction)
- Body Mechanics instruction for childcare, ADL's and IADL's, use of lumbar support
- Lumbar support garments

Correction of Left Lateral Shift



Pregnant Woman Press-Up



Trunk Extension on Wall with and without shift correction



Trunk Extension in 4-Point



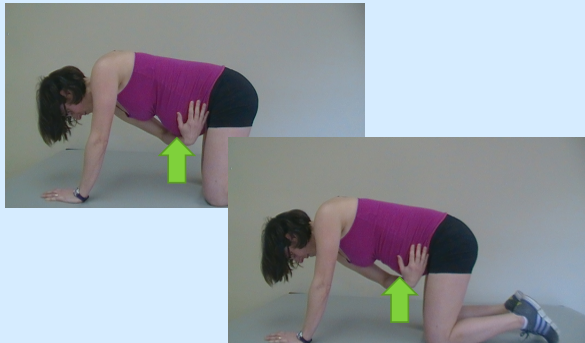
Restoration of Trunk Flexion and Rotation in Standing



Restoration of Trunk Flexion and Rotation in 4-Point



Transverse Abdominis Ex in 4-Point



Transversus Abdominis Exercise While Sitting or When Driving



Body Mechanics Instruction



How to Raise Children Without Breaking Your Back, Pirie and Herman, 1995

MET: FRS correction Sidelying



CORRECTION OF FRS RIGHT IN SIDE LYING

Patient is in right side lying. The operator controls both legs to engage the extension barrier at the specific lumbar level.

The operator engages the barrier into left rotation by rolling the patient back from the left shoulder. The patient grasps the back edge of the table if she is able.

The operator lifts the patient's left knee to engage the side bending barrier.

The patient pulls the left leg down towards the right leg against the operator's resistance. After each contraction, the barrier is moved into any of the three directions.

3-5 repetitions.

Return leg to resting and do rhythmic stab in the new range.

ref: Greenman, PE: Principles of Manual Medicine

Auto-Traction in Doorway



CMO Mother-To-Be Support for L-S Dysfunction



HNP in Pregnancy PT Recommendations for L&D

- First Stage
 - Walk, if comfortable
 - Rest with lumbar support
 - Maintain lumbar lordosis in positioning choices
 - Avoid squatting or FB
- Second Stage
 - Push with open glottis
 - Avoid FB postures including squatting (use L-S support, e.g., in semi-reclining)

Summary of Position Modifications for Women with Pre-existing Spinal or Pelvic Ring

Dysfunction (Boissonnault JS, 2002)

Dysfunction	Positions to Avoid	Recommended Positions
Lumbar or Thoracic Disc Herniation or Bulge	-Squatting -Semi-reclining/knees to chest, -Lithotomy and hands/knees if nerve root tension is an issue	-Semi-reclining/lumbar support -Side lying -Hands/Knees if nerve root tension is not an issue
Intervertebral Spinal Stenosis	Standing	-Any position that opens the intervertebral foramen, side lying with side bending to the opposite side, with or without flexion -Positions that encourage spinal flex, squatting, forward bending over the a Swiss Ball, bean-bag chair or pillows
Spondylolisthesis	Standing	-Any position that avoids increased lumbar spine extension
Sacroiliac Dysfunction	Walking during first stage Semi-reclining with LE's unsupported Lithotomy	-Any position where the LE's are symmetrically supported; semi-reclining with pillows under both knees -Hands/knees, upright kneel if WB OK.
Pubic Symphysis Dysfunction	-Side lying if the LE's are widely abducted -Squatting -Lithotomy	-Side lying if the LE's are not widely abducted -Semi-reclining with knees supported by pillows -Hands/knees or upright kneel if weight bearing is comfortable
Coccyx Dysfunction	Semi-reclining Lithotomy	-Any position where the coccyx is free to move: Side lying, Squatting, Hands/knees, Upright Kneel, Standing

References

- Ashkan K, Casey AT, Powell M., Crockard AH. Back pain during pregnancy and after child birth: an unusual case not to miss. *J Roy Soc Med*, 91 (1998), pp. 88-90
- Boissonnault JS. Modifying labor and delivery positions for women with spine and pelvic ring dysfunction. *Jnl SOWH*, 2002; 76(2): 9-13.
- Brown, M.D., Levi, A.D.O. Surgery for lumbar disc herniation during pregnancy. *Spine*, 2001; 26 (4): 440-443
- Chow J, Chen K, Sen R, Stanford R, Lowe S. Cauda equina syndrome post-caesarean section. *Aus. N Z J Obstet Gynaecol*, 2008; 48(2):218-20.
- Gupta P, Gurumurthy M, Gangineni K, Anarabasu A, Keay SD. Acute presentation of cauda equina syndrome in the third trimester of pregnancy. *Eur J Obstet Gynecol Reprod Biol*. 2008;140(2):279-81.
- LaBan MM; Rapp NS; von Oeyen P; Meerschaert JR. The lumbar herniated disk of pregnancy: a report of six cases identified by magnetic resonance imaging. *Archives of Physical Medicine & Rehabilitation*, 1995 May; 76 (5): 476-9.
- Laban MM, Viola S, Williams DA, Wang A. Magnetic resonance imaging of the lumbar herniated disc in pregnancy. *Am J Phys Med Rehabil*, 1995; 74(1): 59-61.
- Matsumoto E, Yoshimura K, Nakamura E, Hachisuga T, Kashimura M. The use of opioids in a pregnant woman with lumbar disc herniation: a case report. *J Opioid Manag*, 2009 Nov-Dec;5(6):379-82.
- McKenzie R. *How To Treat Your Back*, 7th edition. <http://treatbackpainyourself.com/>
- Timothy J, Anthony R, Tyagi A, Porter O, Van Hille PT. A case of delayed diagnosis of the cauda equina syndrome in pregnancy. *Aust NZ J Obstet Gynaecol*, 39 (2) (1999), pp. 260-261.
- Weinreb, J.C., Wolbarsht, L.B., Cohen, J.M., Brown, C.E.L., Maravilla, K.R. Prevalence of lumbosacral intervertebral disk abnormalities on MRI images in pregnant and asymptomatic nonpregnant women. *Radiology*, 1989; 170 (1 1): 125-128.

Post-partum Coccydynia



www.xtracareequipment.com.au

Nathan et al, 2010. Coccydynia: a review of pathoanatomy, aetiology, treatment and outcome

Table I. Classification of coccydynia based on aetiology

A: Based on aetiology	
1. Idiopathic	
2. Traumatic	
B: Based on pathology	
1. Degeneration of the sacrococcygeal and intercoccygeal disc and joints	
2. Morphology of the coccyx: type II, III, IV, presence of a bony spicule and coccygeal retroversion	
3. Mobility of the coccyx: hypermobile or posterior subluxation	
4. Referred pain: lumbar pathology or arachnoiditis of the sacral nerve roots, spasm of the pelvic floor muscles and inflammation of the pericoccygeal soft tissues	
5. Others: neoplasm, crystal deposits, infections	
C: Somatisation or neurotic	

Coccydynia Etiology & Pathology

- Theory of “coccygeal instability”= luxations and hypermobility ($> 25^\circ$ of flx)
 - MRI study (Maigne, *Spine* 2000)
 - Debated by some (Grassi 2006)
- Anatomical variations $\rightarrow ?\uparrow$ risk (Postachini 1983, Woon 2012)
- Role of body mass index: $\uparrow$ risk (Maigne, *Jnl Bone Jt Surg* 2000)
- Role of coccygeal trauma (Maigne, *Jnl Bone Jt Surg* 2000, Nathan 2010)

Epidemiology & Pathophysiology of Post-partum Coccydynia

- After external trauma, delivery appears to be the 2nd most common cause of coccydynia in women
- Obstetric-related coccydynia is reported to be 3-15% (Maigne 1996 & 2012, Thiele 1963, Bayne 1984, Peyton 1988, Wray 1991, Zayer 1996)
- Prevalence in vaginal births: Unknown (Ryder, 2000)
- Risk factors: BMI > 27, Parity >2, FORCEPS DELIVERY, ventouse (Maigne 2012)
- MOI: Fx & soft tissue trauma 2^o pressure of the presenting part (Kaushal 2005)
- Role of maternal position (theoretical-IB)
 - ↑ Risk: Lithotomy on delivery table & Semi-reclining on a birthing bed
 - Protective: bottom off any surface (squatting, 4-point, sidelying, upright kneeling, standing)

Medical Management of Post-partum Coccydynia

- Steroid injection to SC jt. : Pts with < 6 mos. pain are good candidates (Mitra, 2007)
- NSAIDS
- Coccygectomy- Doursounian 2004 good ref: Surgery only in those refractory to conser. care
- Referral to PT (usually categorized as diathermy and electrical stimulation)
- Post-partum doughnut
- Intra-rectal manipulation

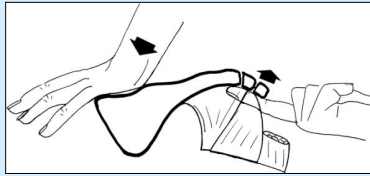
(De Andre's 2003, Hodges 2004, Doursounian 2004, Mitra 2007, Nathan 2010)

Evidenced-Based PT Intervention for Postpartum Coccydynia

- Intrarectal manual treatment (Maigne 2006, 2012, Marinko 2014)
 - Mobilization of the coccyx via muscle contraction
 - Mobilization of the Sacrum at the SC jt while holding the coccyx still intrarectally
 - Distraction of the coccyx with/without lateral deviation
 - Ventral/caudal glides with/without distraction
- Intrarectal Soft Tissue Mobilization (Thiele 1937, 1963)
- Assessment and Rx of bowel dysfunction especially to avoid constipation (Lande 2011)
- Physical Agents for associated Levator Ani Syndrome or PFM hypertonus: (proposed, but not well researched)
 - High volt electrical stimulation
 - Iontophoresis (see chart on next slide)
 - TENS
 - Interferential therapy
 - Pulsed electromagnetic energy
 - US
- Positioning-multiple authors; no research given

Most current reference with good lit review: Johnson and Rochester, 2006

Figure 3



Comparison of Three Manual Coccydynia Treatments: A Pilot Study.
Maigne, Jean-Yves; Chasteller, Gilles
Spine. 26(20):E479-E483, October 15, 2001.

Figure 3. B. Maigne's B technique of coccygeal mobilization. The coccyx is kept in hyperextension, which stresses the sacrococcygeal and intersacral joints and stretches the levator ani.

Table 10-1 Indications and Drugs Commonly Used With Iontophoresis

Indication	Drug	Solution	Delivery Electrode Polarity	Effect
Inflammation	Dexamethasone	4 mg/mL in aqueous solution	Negative	Anti-inflammatory
Calcific tendinitis, myositis ossificans	Acetic acid	2–5% aqueous solution	Negative	Believed to increase solubility of calcium deposits
Adhesive capsules and other soft tissue adhesions	Iodine	5–10% solution or ointment	Negative	Sclerolytic effects
Soft tissue pain and inflammation	Lidocaine	4–5% solution or ointment	Positive	Local anesthetic effects
Muscle and joint pain	Salicylates	10% boric acid solution or 2–3% sodium salicylate solution	Negative	Analgesic and anti-inflammatory
Local subacute or chronic edema	Hyaluronidase	Reconstitute with 0.9% sodium chloride to provide a 1:500 mg/mL solution	Positive	Dispersion of local edema
Skeletal muscle spasm	Calcium chloride	2% aqueous solution	Positive	Decreased excitability of peripheral nerves and skeletal muscle
Skeletal muscle spasm, myofascitis	Magnesium sulfate	2% aqueous solution or ointment	Positive	Muscle relaxant
Skin ulcers	Zinc oxide	20% ointment	Positive	Acts as a general antiseptic and may increase tissue healing
Hyperhidrosis	Tap water	N/A	Alternating polarity	Decreased sweating of palms, feet, or soles

Source: Diccionario, CIB Pharmacology in Rehabilitation, vol. 3, FA Davis, Philadelphia, 2002, p 851.

(As seen in Michlovitz, Bellew and Nolan, 2012)

The Case

- 38 yr old Gravida 6, Para 4, 8 weeks postpartum. Pt. is stay-at-home mom and investment consultant working from home
- CC: Coccyx pain @ 5/10
- Hx of CC: Pt. noticed the pain day 2 pp. Pain has remained the same since.
- Rx to date: ice, Tylenol 3, donut from hospital
- Pt. Goals: Sit at home office desk >2 hrs; Sit to nurse baby without pain

Patient Interview Findings: Post-partum Coccydynia

- Location of Pain: Coccyx and surrounding buttock area. C/o pain with her one attempt at intercourse (last wk) since the birth of the baby
- Nature: deep ache; constant when seated
- Agg: sitting > 5 minutes (nursing, work); hard surfaces worst
- Alev: ice, meds, getting off bottom
- Radiograph negative for Fx
- Orthopaedist offering coccygectomy if PT is unsuccessful

Physical Exam Findings: Post-partum Coccydynia-Visit 1

- Palpation: tender all around coccyx externally; Exquisite tenderness at SC jt line
- Springing SC jt: Painful and reproduces her pain
- Sitting Posture: Antalgic
- Observation: Pt. can contract PF mm but not clear how well she relaxes

PT Interventions: Post-partum Coccydynia-Visit 1

- Unweight the coccyx in sitting
 - Cushion or toweling
 - Provide lumbar support to maintain lordosis
- Review sitting postures in all activities
 - Work, nursing, eating meals, driving, etc.

PT Visit 2 Assessment: Post-partum Coccydynia

- Internal rectal exam
 - Assessed coccyx position: slight deviation to the Right
 - Pain along ventral margin of SC jt line
 - Pain in coccygeus mm bilaterally
 - PF mm contraction: 4/5 strength, 10 sec hold, 10 reps, but unable to fully relax (could not feel a softening of the tissues-finger unable to sink in)

PT Visit 2-6: Post-partum Coccydynia, cont.

- Rx:
 - Biofeedback with rectal probe to down-train PFM, specifically, coccygeus
 - Reviewed sitting posture
 - Began first of 6 visits of iontophoresis with TMJ-size electrode and dexamethazone to SC jt
- Prevention
 - Discussed need to let tissues heal and avoid prolonged pressure on coccyx for many months, even if pain is 0/10
 - Future births: she planned on one more child: discussed positioning for L&D next time

PT Recommendations for L&D- Client with Hx of Coccydynia

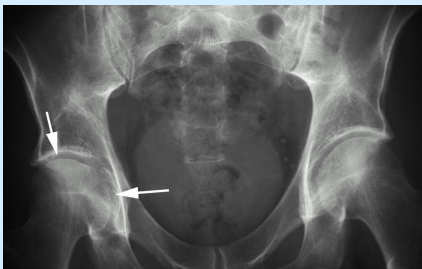
- First stage and second stage avoidance of direct pressure on coccyx
- Positioning options:
 - Squatting or sitting on a birthing stool
 - Sidelying
 - Upright kneeling
 - 4-point
 - Standing



Post-partum Coccydynia References

- Bayne O, Bateman J, Cameron H 1984 The influence of etiology on the results of coccygectomy. *Clinical Orthopaedics and Related Research* 190: 266-272 Payton 1988.
- De André's L, Chaves S. Coccydynia: A Proposal for an Algorithm for Treatment. *The Journal of Pain*, Vol 4, No 5 (June), 2003: pp 257-266
- Doursounian L, Maigne JV, Faure F, Chasteller G. Coccygectomy for instability of the coccyx. *Int Orthop*. 2004 Jun;28(3):176-9.
- Grassi R, Lombardi G, Reginelli A, et al. Coccygeal movement: assessment with dynamic MRI. *Eur J Radiol*. 2007;61:473-479.
- Hodges SD, Eck JC, Humphreys SC. A treatment and outcomes analysis of patients with coccydynia. *Spine J*. 2004 Mar-Apr;14(2):138-40.
- Johnson A, Rochester AP. Coccydynia. *Journal of the Association of Chartered Physiotherapists in Women's Health*. 2006 Spring;19(8): 44-52.
- Kaushal R, Bhanot A, Luthra S, Gupta PN, Sharma RB. Intrapartum coccygeal fracture, a cause for postpartum coccydynia: a case report. *J Surg Orthop Adv*. 2005;16(14):136-7.
- Lande J, Clinton S, Borello-France D. Physical therapy treatment of a patient with a diagnosis of coccydynia. *Int Wom Health Phys Ther* 35(1), 2011, 24-36
- Maigne JV, Doursounian L, Chasteller G. Causes and mechanisms of common coccydynia: role of body mass index and coccygeal trauma. *Spine (Phila Pa 1976)*. 2000;25:3072-3079.
- Maigne JV, Lagauche D, Doursounian L. Instability of the coccyx in coccydynia. *J Bone Joint Surg Br*. 2000;82:1038-1041.
- Maigne JV, Chasteller G, Le Faou M, Archambeau M. The treatment of chronic coccydynia with intralesional manipulation: a randomized controlled study. *Spine* 2006; 31(18): 1621-1627.
- Maigne JV. Postpartum coccydynia: a case series study of 57 women. *Eur J phys rehab med* 2012; 48(3): 387-392.
- Marinakis DN, Matthews P. Clinical decision making for the evaluation and management of coccydynia: 2 case reports. *JOSPT* 2014; 44(8): 615-21.
- Mitra R, Cheung L, Perry P. Efficacy of fluoroscopically guided steroid injections in the management of coccydynia. *Pain Physician*. 2007;10:775-778.
- Michowitz SL, Bellwe RW, Nolan Jr TP, eds. *Modalities for Therapeutic Intervention*, 5th ed. FA Davis Co, Philadelphia 2012.
- Nathan ST, Fisher BE, Roberts CS. Coccydynia: A review of pathoanatomy, aetiology, treatment and outcome. *Journal of Bone & Joint Surgery, British Volume*, 2010 Dec; 92 (12): 1622-7.
- Portacchini F, Mavrosorio M. 1983. Idiopathic coccydynia. Analysis of fifty-one operative cases and a radiographic study of the normal coccyx. *J Bone Joint Surg Am* 65:1116-1124.
- Ryder J, Alexander J. Coccydynia: a woman's tale. *Midwifery*. 2000. Vol. 16 (2), pg 155-160
- Stephenson RG, Shelly EB. Electrical stimulation and biofeedback for genitourinary dysfunction. In: Robinson AJ, Snyder-Mackler L, eds. *Clinical Electrophysiology*, 3rd ed. Lippincott Williams & Wilkins, Wolters Kluwer, Philadelphia 2008.
- Thiele G 1963 Coccydynia: cause and treatment. *Diseases of the Colon and Rectum* 6: 422-436.
- Thiele GH. Coccydynia and pain in the superior gluteal region and down the back of the thigh: causation by tonic spasm of the levator ani, coccygeus and piriformis muscles and relief by massage of these muscles. *JAMA* 1937;109: 1271-5.
- Woon JT, Jennings MB. Clinical anatomy of the coccyx: a systematic review. *Clin Anat*. 2012;25:158-167. <http://dx.doi.org/10.1002/ca.21236>
- Wray C, Easton S, Hopkinson J 1991 Coccydynia, aetiology and treatment. *Journal of Bone and Joint Surgery* 73 (2): 315-318
- Zayer M 1996 Coccydynia. *Ulster Medical Journal* 65 (1): 58-60 Maigne J, Tamalet B 1996 Standardized radiologic protocol for the study of common coccydynia and characteristics of the lesions observed in the sitting position. *Spine* 21 (23): 2588-1993

Transient Osteoporosis of the Hip (TOH) in Pregnancy



radiographics.rsna.org

What is TOH?

- TOH is a subset of Osteoporosis in pregnancy
- Other osteoporotic areas seen in pregnancy:
 - Lumbar spine
 - Wrist
 - Tibia
- Diagnosis made by MRI, radiographs (pp), bone scans, and R/O diagnosis
- Referred as transient osteoporosis during pregnancy due to the self-limiting nature and spontaneous recovery.
- Fractures are infrequent (1%)
- True incidence during pregnancy is unknown

Pathophysiology of TOH in Pregnancy

- CA requirements to mineralize a fetal skeleton should not challenge maternal bone stores of CA (Sowers, 2000)
 - Maternal skeleton calcium store is approximately 1000 grams.
 - 30 grams of calcium are required for fetal skeleton mineralization
- Theory
 - Women with osteopenia or bone density challenges who become pregnant are at risk for osteoporosis in pregnancy (Drinkwater 1991, Khastgir, 1996)
 - Genetic link (Carbone 1995, Dunne 1993)
 - Chemical/Hormonal mediation? (Chigira, 1988)

A Genetic Link?

- Carbone, et al, 1995. Described two patients with osteoporosis during pregnancy. Daughters demonstrated osteopenia at the wrist as did the two patients at 10 year FU.
- Dunne, et al, 1993. Studied 35 women with Hx of pregnancy related osteoporosis. Found a significantly higher prevalence of Fx occurring at a younger age in the mothers of these women.

Risk Factors for Osteopenia during Pregnancy

- Family history
- Immobilization/inactivity (bed rest in high risk pregnancies)
- Dietary deficiencies (Ca intake below 1200-1500mg, ↓ Vitamin D)
- Toxins (tobacco and alcohol)
- Medications (anti-coagulants-thromboemboli)
- Comorbidities

Medical Management of TOH in Pregnancy

- Imaging: only if they suspect a Fx. Likely wait until pp
- Rest and restricted WB (NWB or WB as Tolerated) with assistive devices prn
- Work restrictions as needed
- Postpartum: imaging, bisphosphonates (rare), calcium, calcitonin, continued WB restrictions and gait-aid prn

TOH Presentation and Prognosis

Common presentation (Samdani, 1998)

- Onset: Generally in 3rd trimester
- Pain locale: inguinal or greater trochanteric regions with referral to anterior thigh.
- ROM: limited at the hip
- Functionally restricted weight bearing

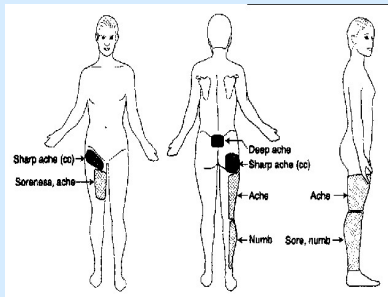
Prognosis

Recovery from 2 to 12 months post-partum and may be prolonged due to lactation (Carbone 1995, Drinkwater 1991, Dunne 1993, Funk 1995, and Sowers 1996)

The Case

- 32 year old, gravida 1, para 0, 29 weeks gestation.
- credit records specialist (sits all day)
- Referred to PT from Nurse midwife/Obstetrician 2 weeks prior to initial PT visit
- Diagnosis of "R sciatica". Pt. had been seen in PT before for same Dx, but on the Left.
- PMH: L₅-S₁ HNP (1996), forearm Fx age 19

(Boissonnault W, 2001, Boissonnault J, 2005)



Patient Interview Findings- TOH in Pregnancy

- Chief complaint: Deep right groin pain varying from 4-9/10, sharp and throbbing, "deep inside my hip".
- Groin symptoms present for 4 weeks, initially as intermittent stiffness, then, 10 days prior to PT, became intense and sharp.
- Insidious groin stiffness/pain onset.

Aggravating & Alleviating Factors TOH Case

- Aggravation:
 - Standing: 10 minutes
 - Walking: 2-3 blocks
 - Transitional movements
 - Activities of daily living such as dressing that required hip flexion
- Alleviation:
 - Sitting
 - Recumbency

Pt. Interview: Secondary Symptoms TOH Case

- Ache: low lumbar, right buttock and lateral thigh, intensity of 2-5/10.
- Insidious onset 12 weeks prior to initial PT visit (approximately 17 weeks gestation)
- Slow, progressive worsening
- Aggravated by sitting > 10 min., F-Flex postures
- Alleviated by changing positions, supine lying

Pt. Interview: Secondary Symptoms, continued, TOH Case

- Paresthesia right lateral lower leg with insidious onset 12 weeks prior to initial PT visit.
- Aggravated by sitting > 10 minutes and F-Flx postures
- Alleviated by recumbency
- Previous Hx: similar Sx in Left LE 1996

Differential Diagnosis

- Origin(location) of CC considered:
 1. Pubic Symphysis
 2. SIJ ®
 3. Lower T-spine/L-Spine
 4. ® hip joint or soft tissue lesion

NOTE: Use of patellar-pubic percussion test (PPPT) would help R/O Fx

Physical Examination Findings TOH

Case

- Slow, antalgic gait
- Stance: minimal WB on Right LE
- Palpation: moderate to severe tenderness right femoral triangle
- Pubic Symphysis non-tender to palpation and springing
- Neuro exam: decreased light touch right, lateral lower leg; right Achilles reflex 1+

Physical Exam, continued TOH Case

- Trunk ROM: CC provoked with FB and right SB; limited in FB, Right SB and BB (with c/o right L/S pressure)
- SLR ®: CC provoked at 30°
- SIJ screening/provocation tests were neg.

Physical Exam, continued Hip ROM, TOH Case

Motion	Right Hip (AA/P ROM)	Left Hip (AROM)
Flexion	85/85	125
Internal Rotn	5/5	40
External Rotn	50/55	55
Abduction	20/20	45
Extension	5/8	15
Adduction	NT	NT

Physical Exam, continued End Feel, ® hip, TOH Case

- Empty end feel: with hip flx and IR, and SLR to 30°
- Spasm end feel: with hip abduction
- Capsular end feel: with ER and extension

Assessment of Clinical Presentation TOH Case

Symptoms

- Sudden onset of CC
- Insidious onset of CC
- Severe pain, 9-10/10
- No relief of pain with rest
- Inability to actively lift ® LE
- MD and CNM unaware of ↑ Pt.Sx

Signs

- Severe ROM loss ® hip
- Empty end feel Flx, IR, SLR
- Spasm end feel Abd
- Prov. CC SLR 30°

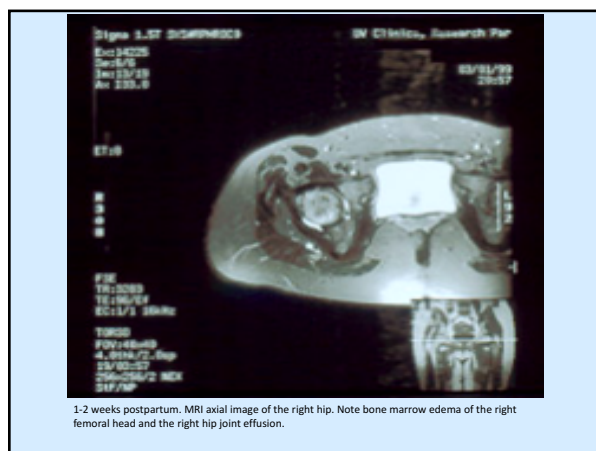
Referral Generated back to CNM with specific concerns about R hip

PT Interventions and Medical Management, TOH Case

- Crutches
- Off work with decrease in Sx
- Seen 10 days PP in PT S/P vaginal delivery with similar presentation, so referred back to CNM/OB with subsequent referral to an Orthopedist.
- Subsequent Plain films and MRI suggested TOH: ↓ BMD in femoral head, neck, and acetabulum without collapse.
- Lab tests negative





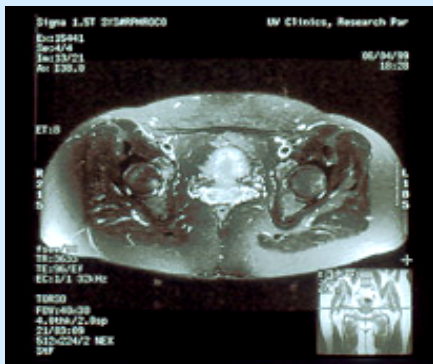


Management of TOH, Postpartum

- WB to tolerance with crutches
- Aquatic PT for ambulation, strengthening, ROM and pain relief.
- FU plain films at 10 weeks pp
- FU MRI at 12 weeks pp
- Told to progress to land-based program to rebuild bone density (Pt. moved away after this)



Follow-up conventional radiograph of the pelvis and hips taken approximately 13 weeks after the initial radiograph. According to the radiologist, this radiograph revealed normal mineralization of the right femur and acetabulum.



MRI axial follow-up of the right hip taken approximately 3 months after the initial physical therapy visit. Slight residual high-signal intensity area in the right femoral head and acetabulum noted by the radiologist.

PT Recommendations for L&D- TOH in Pregnancy

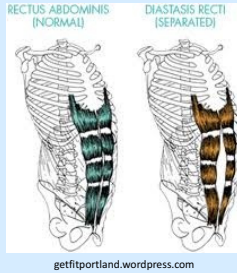
- Semi Reclining with hip supported by pillows in Flx, (limited) AB and ER
- Avoid WB postures and consider hip ROM limitations
- Regional Anesthesia concerns: no pain feedback

TOH References

- Boissonnault WG, Boissonnault JS. Transient Osteoporosis of the Hip Associated with Pregnancy. *JOSPT*. 2001;31(7):359-367.
- Boissonnault JS, Boissonnault WG, Bartoli P. Osteoporosis During the Childbearing Year. *Journal of Women's Health Physical Therapy*. 2005 Winter; 29 (3): 28-32.
- Khastgir G, Studd JW, King M, et al. Changes in bone density and biochemical markers of bone turnover in pregnancy-associated osteoporosis. *Br J Obstet Gynaecol*. 1996;103:716-718.
- Drinkwater BL, Chestnut CH. Bone density changes during pregnancy and lactation in active women: a longitudinal study. *Bone Miner*. 1991;14:153-160.
- Ohgira M, Watanabe H, Udagawa E. Transient osteoporosis of the hip in the first trimester of pregnancy. A case report and review of Japanese literature. *Arch Orthop Trauma Surg*. 1988;107:178-180.
- Carbone LD, Palmieri G, Graves SC, Smull K. Osteoporosis of pregnancy: long-term follow-up of patients and their offspring. *Obstet Gynecol*. 1995;86:664-666.
- Dunne F, Walters B, Marshall T, Heath DA. Pregnancy associated osteoporosis. *Clin Endocrinol (Oxf)*. 1993;39:487-490.
- File P, Wood JP, Krepleck LW. Diagnosis of hip fracture by the auscultatory percussion technique. *Am J Emerg Med*. 1998;16 (2):173-176.
- Magee 2002.
- Samdani A, Lachmann E, Nagler W. Transient osteoporosis of the hip during pregnancy: a case report. *Am J Phys Med Rehabil*. 1998;77:153-156.
- Funk JL, Shohack DM, Genant HK. Transient osteoporosis of the hip in pregnancy: natural history of changes in bone mineral density. *Clin Endocrinol (oxf)*. 1995;43:373-382.
- Sowers M. Pregnancy and lactation as risk factors for subsequent bone loss and osteoporosis. *J Bone Miner Res*. 1996;11:1052-1060.

DIASTASIS RECTI ABDOMINIS -CURRENT EVIDENCE AND PRACTICE

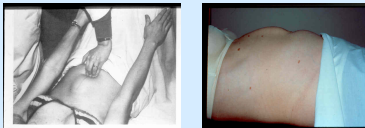
Diastasis Recti Abdominis



DRA Defined

- Literature is conflicted: It has been defined as separation of the Recti bellies at the linea alba when the Inter Recti Distance (IRD) is:
 - >1.5 cm (Gilleard and Brown, 1996)
 - >2 cm (Lo et al., 1999)
 - >2.5 cm (Candido et al., 2005)
 - >2 finger widths during a partial sit-up (Bursch, 1987; Sheppard, 1996)

(Coldron, 2008)



Normal IRD

- Dependent on a # of factors:
 - Gender (males exhibit > IRD than nulliparous women above umbilicus, though not below umbilicus)
 - Parity (parous women > IRD than nulliparous women)
 - Measurement tool (US, caliper, fingers)
 - Location along the linea alba (IRD > above umbilicus than below)
 - Trunk at rest or actively flexed

(Coldron 2008, Chiarello 2013)

Does DRA Resolve Spontaneously?

- Liaw (2011)-Study of a cohort of 40 pp women implies, “yes”

Locations	7wk Postpartum	6mo Postpartum	D	P Value
2.5 cm above	1.97 ± 0.71	1.94 ± 0.72	0.17 ± 0.35	.057
Upper margin	2.29 ± 0.59	2.23 ± 0.65	0.26 ± 0.41	.007
Lower margin	1.99 ± 0.65	1.85 ± 0.62	0.18 ± 0.41	.052
2.5 cm below	1.30 ± 0.77	1.16 ± 0.58	0.14 ± 0.40	.028

Abbreviations: D, mean difference between 7 weeks and 6 months.
 *Data are mean ± SD cm. Measurements were taken 2.5 cm above the umbilical ring, upper margin of the umbilical ring, lower margin of the umbilical ring, and 2.5 cm below the umbilical ring.
 †Significantly different between 7 weeks and 6 months postpartum (P < .05).

- But, we know not all DRA resolves: Raney found 1/3 of women undergoing hysterectomy had mild→ severe DRA

(Raney 1990, Spitznagle 2007)

Incidence/Prevalence of DRA

- Candido 2005: 35% immediate pp
- Boissonnault 1988: 66% of 3rd trimester women in a cross-sectional study. Bell shaped curve. Finger measurement; cross-sectional

	Group					Total
	First Trimester	Second Trimester	Third Trimester	Immediate Postpartum	Later Postpartum	
Present	0	4	10	8	4	26
Absent	15	11	5	7	7	45
TOTAL	15	15	15	15	11	71

*χ² = 13.54, df = 4, p < .05.

Location of DRA

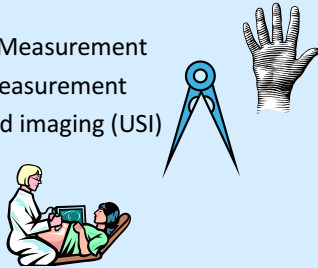
- Rett 2009
 - The prevalence of DRA and mean DRA were > above the umbilicus both among multiparae and primiparae.
 - Below the umbilicus, the mean DRA was > among multiparae (finger measurement)
- Boissonnault and Blaschak (1998): greatest incidence @ umbilicus

Changes to the abdominal wall in pregnancy

- Coldron 2008: US study showed ↑ IRD & thinner, wider, longer RA, compared to nullip controls, with gradual reduction in IRD @ 8wks pp, though incomplete resolution
- Gilleard & Brown 1996: those with DRA may have a ↓ capacity for force generation; subjects with a DRA of >35mm (1.38 In.) ↓ success performing a pelvic tilt or a trunk curl than those without DRA
- Liaw et al 2011: women @ 6 mos pp > IRD values and ↓ abdominal function compared to nullips & ↑ IRD correlated with ↓ abdominal function

Assessment

- Fingertip Measurement
- Caliper Measurement
- Ultrasound imaging (USI)



Assessment

– Reliability

- Inter-rater problematic with finger method but intra-rater reliability was established. (Bursch 1987)
- Calipers found to be sufficiently inter-rater reliable (Boxer 1997)
- Real Time USI also found to be inter-rater reliable and valid compared to calipers, fingers (Liaw 2011, Mota 2012)

– Validity of US measurements

- Mendes 2007: USI valid compared to measurements during surgery for DRA at and above umbilicus but not below



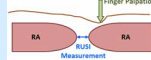
FIGURE 1 To measure intercostal distance (A) 5 cm above and below the umbilicus (indicated with skin markings), the inside jaws of the calipers are placed between the medial edges of the right and left rectus abdominis muscles as pointed by the examiner.

Chavakis 2013

Assessment-fingers



- Finger Measurement
 - Technique: Place fingertips horizontally across abdomen @umbilicus, above and below
 - Ask client to perform a modified curl-up, keeping inferior angle of scapula on the table
 - Place fingers into the gap; feel for the medial borders of each rectus belly and insert fingers to fill the gap
 - Number of fingers in the gap determines the “fingertip measurement”
- Chiarello and McAulley (CSM 2014): concern of finger placement and, inter-rater reliability



DRA Measurement: Caliper Technique

Method

- ☐ Hook-lying
- ☐ Mark location along LA
 - ☐ Water soluble pen
 - ☐ Tape measure
- ☐ Palpate medial borders of RA



Nylon Digital Caliper
(Mitutoyo American Corporation)



Used with permission from Chiarello, 2014

DRA Measurement: Caliper Technique

Method

- ☐ Mark measurement positions
- ☐ Palpate medial borders of RA
- ☐ Position inside caliper jaw between muscle belly at palpating finger perpendicular to the surface
- ☐ Adjust caliper to perceived IRD width
- ☐ Condition
 - ☐ Passive - Muscles at rest
 - ☐ Active - Partial curl-up



Used with permission from Chiarello, 2014

DRA Measurement: Caliper Technique

• Clinical Relevance

- Inexpensive, valid and reliable tool in the hands of a trained clinician
- Calipers may measure IRD width larger than direct measurement or imaging, particularly below the umbilicus
- Allows for documentation of change
- Preferable to finger-tip width when imaging is not available.

Used with permission from Chiarello, 2014

DRA Measurement: Caliper Technique

• Reliability

- Dial Calipers
 - High Intra and Inter-rater at rest & active (ICC .90-.95) (Boxer & Jones, 1997; Hitchman et al., 1997)
- Digital Calipers
 - High Intra-rater with muscles contracting and at rest (ICC .94-.99) (Chiarello McAuley, 2013)
 - High Inter-rater (ICC .87) (Chiarello et al. 2005)

• Validity

- Concurrent validity of calipers compared to USI (Chiarello McAuley, 2013)
 - Good above the umbilicus with muscles contracting and at rest (ICC .71-.79)
 - Below the umbilicus calipers measured IRD significantly larger than USI with muscles at rest and contracted

Used with permission from Chiarello, 2014

DRA Measurement-USI

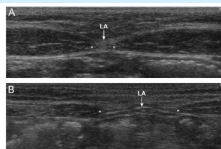


Fig. 1. Ultrasound images showing the intercostal distance (IRD) and linea alba (LA) between the medial ends of the right and left rectus abdominis. (A) Normal subject. (B) A normal subject and with IRD of approximately 25 cm. (B) A postnatal subject with the LA and an IRD of approximately 25 cm. *Medial borders of the left and right rectus abdominis.

Coldron, 2008



FIGURE 2. Placement of the ultrasound imaging transducer, perpendicular to the linea alba, to measure intercostal distance 4.5 cm above and below the umbilicus (indicated with skin markings).

Chiarello, 2013

Etiology/Risk factors

- Candido 2005: Immediate pp women (35% [76/208] with DRA)
 - Performing childcare during pregnancy as a predictive risk factor for DRA
 - Vigorous ex and moderate walking was protective



www.elanceagain.com

- Lo, 1999:

- Multiparity,
- Maternal age (>34 years)
- Larger babies
- Greater weight gain
- Caesarean section
- Multiple gestation

(though major limitations in this study)



Treatment: Strengthening. But How?

- Noble (2003): head lift with exhalation (and hand-crossing to bring two sides of rectus together)



www.befitmom.com

- Adding a posterior pelvic tilt
↑ RA EMG

(Fransman-VanSanten 1984, Drysdale 2004)

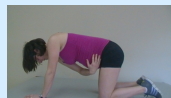
- Some have advocated for addition of a sheet to pull the two sides together; though not scientifically studied



www.pregnancyandbaby.com

Treatment, cont., Transversus Abdominis

- Collie 2004: Case study pp.
 - DRA did not close, but pain and swelling were reduced
- Chiarello 2005: 18 pregnant women; 8 exercised and 10 did not.
 - ↑ incidence of DRA (per caliper measurement) in non-exercisers (90% vs. 12.5%).
 - Ex focused on TRa and obliques (note small convenience sample, not randomized or blinded)
- TRa and RA: See table from Keeler, 2012 on next slide
- Shepard, 1996: Case study supporting TRa and RA training.
- Litos, 2014: Case study using deep local mm (TRa, PF, multifidi) and progressed to strengthening global hip and trunk mm. Successful closure of 11 cm DRA



Bottom Line: we don't know which Rx is best

Keeler et al 2012

Table. Evidence-Based Physical Therapy Interventions to Treat Diastasis Rectus Abdominis (DRA)^{a,b,16-17,28}

Intervention(s)	Description	Intervention	Outcome
Quality of Life Measurements and Physical Therapy Management of a Female Diagnosed with Diastasis Recti Abdominis; 2009; Zapata-Lucas M	Case study 36-year-old woman, postpartum diastasis rectus abdominis	12 visits, 6 wks TA strengthening, while avoiding RA	Increase walking tolerance Abolished pain Increase in scores on the Short Form-36 Health Questionnaire
Physical Therapy Treatment for Diastasis Recti: A Case Report; 2004; Collic MC, Harris BA	Case report 34-year-old woman, 6 years postpartum DRA 4 fingers	3 months, 3 times/wk Therapeutic exercise: Abdominal drawing-in maneuver in multiple positions; bridging and quadruped arm/leg lifts Manual therapy: Soft tissue mobilization and MFR Devices: Elastic abdominal binder worn with functional activities Modalities: Heat, ice, and ultrasound	Increased walking tolerance Increased sitting tolerance DRA still present 1 year postdischarge Abdominal swelling and pain with increased activity Patient reported minimal adherence to home exercise program No DRA upon examination
Diastasis of the Recti Abdominis in Pregnancy: Risk Factors and Treatment; 1999; Candido G, Lo I, Janssen PA	Retrospective case-control 66 postpartum women with ≥ 2.5 cm separation or visible bulge	Phase 1: TA activation in various positions (posterior pelvic tilt and Kegel's) abdominal binder with functional activities if DRA is severe Phase 2: Head and scapular tilt with posterior pelvic tilt in hook lying. Add leg/arm movements Phase 3: Self-progression to low-impact aerobic exercise No set timeline; depends on progression through phases	Exercise levels before and during pregnancy are important indicators for a faster recovery following this protocol
The role of transverses abdominus in postpartum correction of gross diastasis recti; 1996; Shephard S	Case study comparing TA training vs TA and RA training	TA contraction in various positions, progress to functional activities, 10 wks	TA only: reduction from 60 mm to 7 mm TA and RA: reduction from 100 mm to 7 mm
The effects of an exercise program on diastasis recti abdominis in pregnant women; 2006; Chianello	Quasi-experimental post-test design Exercise (8 women) vs no exercise (10 women) with prenatal women	Six 90-min classes including abdominal strengthening, pelvic floor strengthening, and education regarding prenatal body mechanics	Significantly smaller separation with the exercise group Subjects of the nonexercising group who had well-conditioned abdominals prior to pregnancy also had a smaller separation when compared with women who did not have well-conditioned abdominals prior to pregnancy

Abbreviations: MFR, myofascial release; RA, rectus abdominis; TA, transverse abdominis.

Treatment, continued; Corsets

Corsets have been proposed, but not scientifically studied
(Collie 2004, Keeler 2012)



bellybuttonboutique.wordpress.com

Some therapists advocate for usage when the client complains of “my guts falling out”. Or as an initial step with a large DRA whilst the woman gains proprioceptive control.
Others suggest usage while exercising or performing strenuous ADLs

Treatment, continued; Taping

Used by 40.8% of survey responders in USA, but not researched (Keeler 2012)



So What?-Abdominal Function

- **Gilleard and Brown**, (1996) found ↓ functional strength and endurance in 6 women with DRA
- **Liaw** (2011):
 - Muscle strength and static endurance improved as IRD ↓ (measured by US) in a longitudinal cohort of 40 pp women. Measured @ 7 week pp & 6 mos. pp
 - Abdominal mm function remained impaired in postpartum women compared to a group of nulliparous women

The “So What?”-Impact Elsewhere

- DRA and lumbopelvic pain (Parker 2009):
 - Women with a DRA tended to have a ↑ degree of abdominal or pelvic region pain compared to controls but not functional deficits.
 - And no ↑ LBP
- DRA and urogynecologic dysfunction (Spitznagle 2007)
 - Overall DRA prevalence of 52% within the 547 charts reviewed. 66% of the patients with a DRA had one or > pelvic floor dysfunctions present. (Note: Study cannot determine causality!)
 - The mean age of the subjects was 52.5 years and 58% of the subjects were menopausal.

Demo: Manual Assessment, Exercises, Support Garments

- DRA assessment with fingertip method
- Practice RA-Noble exercise with and without pelvic tilt
- Practice RA-TRa-Pelvic Tilt together
- Practice TRa contraction with other UE, LE exercises
- **OBSERVE THE BELLY! WATCH FOR BULGING!**
- Discussion on binders and tape options

DRA Fingertip Assessment





Fig. 3-3. Testing for diastasis recti. (A) Starting position. (B) Final position.

DRA HEP



Only a head lift with or without pelvic tilt and Transversus contraction

References Diastasis Recti Abdominis

- Boisenmaul L, Blaschak M. Incidence of diastasis recti abdominis during the childbearing years. *Phys Ther* 1989; 68:1092
- Bower, S. Intra-rater reliability of rectus abdominis diastasis measurement using dial calipers. *The Australian journal of physiotherapy* 43.2 (1997): 109-114.
- Burch SG. Intra-rater reliability of diastasis recti abdominis measurement. *Phys Ther* 1987 ; 67 : 1077 – 1079 .
- Candido G, Jo T, Janssen PA. Risk factors for diastasis of the recti abdominis . *J Assoc Chiropr Physiother Women's Health*. 2005 ; 97 : 49 – 54 .
- Chiarello CM, Faldone LA, McCaslin KE, Patel MN, Ulfery KR. The effects of an exercise program on diastasis recti abdominis in pregnant women . *J Women's Health Phys Ther* 2005; 29 : 11 – 16 .
- Chiarello CM, McHaley JA. Concurrent validity of calipers and ultrasound imaging to measure inter-recti distance. *JOSPT* 2013; 43(7): 495 – 503 .
- Coldron T, Stokes MJ, Newham DJ, Cook K. Postpartum characteristics of rectus abdominis on ultrasound imaging . *Manu Ther*. 2008 ; 13 : 112 – 121 .
- Collie ME, Harris SA. Physical therapy treatment for diastasis recti: a case report . *J Soc Women's Health*. 2004 ; 28(2): 11 – 15 .
- Drysdale CL, Earl H, Hertel L. Surface Electromyographic Activity of the Abdominal Muscles During Pelvic-Tilt and Abdominal-Hollowing Exercises. *J AHA Train*. 2004 Jan-Mar; 10(1): 32-36.
- Fransman-VanSanten T. Strengthening of the abdominal muscles for the patient with a rectus diastasis. *Journal of Nederlands Tijdschrift Fysiotherapie* 94:93-95,1984
- Graham WL, Brown JMM. Structure and function of the abdominal muscles in primigravida subjects during pregnancy and the immediate postbirth period . *Phys Ther*. 1976 ; 76 : 759 – 762 .
- Keeler J, Albrecht M, Eberhardt L, Harris L, Donnelly C, Lowe D. Diastasis Recti Abdominis: A Survey of Women's Health Specialists for Current Physical Therapy Clinical Practice for Postpartum Women. *Journal of Women's Health Physical Therapy*. 2012 Jan-Dec; 36 (3): 151-62.
- Liew LL, Hsu ML, Lee CF, Liu MF, Hsu AT. The relationships between inter-recti distance measured by ultrasound imaging and abdominal muscle function in postpartum women: a 6-month follow-up study . *J Orthop Sports Phys Ther*. 2011 Jun;41(5):435-43.
- Litz K. Progressive therapeutic exercise program for successful treatment of a postpartum woman with a severe diastasis recti abdominis. *JWOPPT*. 2014; 38(2): 58-65.
- Lo T, Candido G, Janssen P. Diastasis of the recti abdominis in pregnancy: risk factors and treatment . *Physiother Can*. 1999 ; 51 (1): 32 – 37 .
- Mendes A, Nakai FX, Veiga DF, et al. Ultrasonography for measuring rectus abdominis muscle diastasis . *Acta Cr Bras*. 2007 ; 22 (82) : 182 – 186 .
- Motta P, Pascual AG, Sanchez E, Ba K. Test-retest and inter-rater reliability of 2-dimensional ultrasound measurements of distance between rectus abdominis in women. *J Orthop Sports Phys Ther*. 2012;42(11):940-6.
- Noble L. *Essential Exercise for the Childbearing Year*. 4th ed. Harwich, MA : New Life Images ; 2002.
- Parker MA, Miller AL, Dugan SA. Diastasis rectus abdominis and lumbopelvic pain and dysfunction: are they related ? *J Women's Health Phys Ther* 2009 ; 33 : 15 – 22 .
- Ranney B. Diastasis recti and umbilical hernia causes, recognition and repair. *SO Med*. 1990; 43(14):58.
- Ratt MT, Braga MD, Bernardes ND, Andrade SC. Prevalence of diastasis of the rectus abdominis muscles immediately postpartum: comparison between primiparae and multiparae. *Revista Brasileira de Fisioterapia*. 2009; 13 (4):275-280 .
- Sheppard S. The role of transversus abdominus in post partum correction of gross diastasis recti . *Manu Ther*. 1996 ; 1 : 214 – 216 .
- Springate TM, Leung FC, Van Tilburg LR. Prevalence of diastasis recti abdominis in a urogynecological patient population. *Int Urogynecol J Pelvic Floor Dysfunct*. 2007 Mar;18(3):321-6.