Evidence in Action

Core Stabilization for Low-Back Pain

By Makani Lew, BSc, DC

INTRODUCTION

Many chiropractors and manual therapists tell their low-back pain patients to do core stabilization exercises. However, several questions arise from this recommendation:

1) Do core exercise programs actually help people with low-back pain (LBP)?
2) Which exercises work?
3) And most important: How can a clinician determine if the exercises are working?

Today's spinal stabilization or core exercises are different from those in the past. The classic core progression for low-back patients used the pelvic tilt as its centerpiece. The supine patient was instructed to lie on his or her back with knees bent and feet on the floor and to "push the lower back into the mat"[1] or to be "hook lying, active pre-position in posterior tilt."[2] After the pelvis was tilted or stabilized, the classic core progression added arm and leg movements: single arms first; single legs next; followed by finishing with both arms and legs in an alternating "cross-crawl" or reciprocating movement pattern. This was referred to as the "dead bug," or more appropriately, the "dying bug," since the bug was still moving. This arm, leg, and cross-crawl movement sequence was to be done in 4 positions: supine with knees up and feet on the ground "hook lying," supine with buttocks up and feet on ground "bridge," on hands and knees "quadruped," and prone—ending up looking like a "swimmer."[2] Toward the end of the 1990s, the transversus abdominis muscle was the focus. Patients were instructed to engage the transversus abdominis by drawing the navel back toward the spine[3] in a movement called "hollowing," as if pretending to button a pair of skinny jeans. However, on further evaluation, although a strong transversus abdominis is important to spinal stability, the "hollowing" technique was found not to provide core stability, as had been anticipated.[4]

The newest generation of spinal stabilization exercises involves co-activation of all of the core muscles and includes instructing the patient to learn how to maintain a stiffening effect of the torso called "abdominal bracing." The core muscles that are engaged in the abdominal brace technique are made up of 6 sides:[5,6]

1) Anterior: abdominals, especially the transversus abdominis
2) Posterior: lumbar extensors (paraspinals), especially the multifidi
3) Lateral (left and right): quadratus lumborum and oblique abdominals
4) Superior: diaphragm
5) Inferior: pelvic floor muscles

Abdominal bracing involves engaging the entire cylinder of the core, which McGill[4] calls stiffness. When done correctly, the abdominal brace will cause the lower anterior rib cage to tuck downward as it would on fast, forced exhalation without causing any flattening of the lumbar lordosis.[4] The patient should be instructed to brace his or her body as if a ball is going to be thrown at the body.

This article will help you decide if these new core exercises have been shown to make a clinical difference in a patient's recovery and injury prevention from future low-back pain.

CASE PRESENTATION

Our patient is a 48-year-old, mesomorphic, moderately fit female with a history of mild-to-severe bouts of low-back pain. She keeps her back problems under control with a regular regimen of diversified technique chiropractic adjustments (full-spine and extremity, as needed,

2-3 times a month) combined with walking and resistance weight exercises several times a week. During the past 20 years, she has had several major episodes that left her unable to move for several days at a time due to pain in her lumbar muscles. Activities that worsen her pain include gardening (pulling weeds, digging), vacuuming, sitting for extended amounts of time, uphill hiking, and prolonged walking. During pain episodes, she uses ice at first, then heat, motor nerve stimulation (set to fatiguing tetany, 80-120 cps), and natural analgesics (homeopathic *Arnica Montana*, Dee Cee Labs Formula 303, and Boswellia root). Because her muscles are hypertonic during these flare-ups, she is adjusted using a drop method, rather than side posture.

Today, she slowly entered our clinic in a painful, antalgic, forward lean after having another acute episode. She's worried because her previous episode was only 6 months ago. Her history reveals no significant cause or injury. However, after thorough questioning, she admits she sat at the computer much longer than usual this past week, "all day, every day." Then, when she was sweeping up debris at a fast pace on the front porch, her low back felt as if it "snapped." Knowing she was in trouble, she hobbled to the refrigerator to grab an ice pack. She then lay on the couch. The pain seemed different this time, however, because it was deep. Although all her low-back muscles are tight, there is no specific point of tenderness to palpation or pressure. Physical examination shows a painful and extremely limited range of motion in all directions, with most discomfort in active or passive flexion and least discomfort in passive extension (prone press up). Her pain is severe, an 8 out of 10 on an NRS. It does not radiate, and does not change with Valsalva's maneuver. Some relief is experienced on the Shear Stability Provocation Test[7] throughout the lumbar spine. She is limited to 20 seconds on the right-side-down bridge (side plank on the knees), and is unable to do a front or left-side, down-side bridge.

EMG studies have demonstrated muscle wasting and early fatigue in LBP patients with a likely risk of residual weakness of intrinsic muscles after the pain has resolved.[8,9] In the chiropractic office, isometric hold-to-exhaustion tests (referred to as "endurance tests") can be used to provide subjective, objective, and quantifiable clinical data. Some of these include[10,11,12,13]

1) isometric trunk extension off the edge of table (Sorensen's test)
2) isometric trunk flexion starting from 60 degrees or the active sit-up test
3) isometric lateral flexion (side plank, also known as side bridge on the ankles)
4) co-activation of isometric flexion and extension (front plank)

These endurance tests should be able to be performed for 3 to 4 minutes, depending on the movement.[14] Other tests to use as benchmarks pre- and post-treatment include activity questionnaires, observing for aberrant or hypermobile movement patterns, or evidence of instability that appears to become stable once the extensor muscles are activated (Prone Instability Test).[11] This last test has many names and is also known as the Lumbar Joint Shear Stability Test[15] or the Shear Stability Provocation Test.[7] Preliminary clinical prediction rules suggest that there is a greater chance of recurrent LBP if there are multiple positives in these tests.[11]

Mechanical LBP in itself can be caused by many things (facet joint capsule, spinal ligaments or muscles, intervertebral disc) and is almost always a combination of these.[16,17] In my patient's case, flexion appeared to have played a part in causing the problem (sitting) and is now one of her postural intolerances. She appears to have mechanical LBP with flexion intolerance and extension bias.[4] A review of the anatomy and neurology of the spinal motion segment suggests that she has caused a tensile load injury, most likely a tear, in the posterior annulus fibrosis. The innervation of the posterior aspect of the intervertebral disc is the recurrent meningeal nerve. Of note, the innervation to the zygapophyseal joint is the medial branch of the

posterior primary rami, which also innervates the medial structures of the posterior spinal elements such as the ligaments and muscles that lie between the spinous processes and the skin that covers them.[17] Since she has no tenderness to touch but instead feels a deep indistinct area of pain, this suggests that it's a deeper structure and a deeper innervation.

Beyond recovery from this episode, my patient wants to know how she can become strong again to prevent this from recurring. She is afraid that she will never be well again.

SEARCH METHODS

Use the **PICO** guideline to focus the search.[18] (**P**=Patient/population studied or problem, **I**=Intervention or treatment used, **C**=comparison or control, **O**=outcome, expected or desired responses to treatment.)

P- chronic low-back pain, middle-aged patient
I- core stabilization exercises
C- vs. nothing or general exercises
O- decreased pain, increased range of motion, prevention of future injuries

It is essential to pick good keywords for scientific literature and use a powerful scientific search engine such as PubMed, www.ncbi.nlm.nih.gov/pubmed. To find out what the best keywords would be, use the MeSH index on PubMed and use the "AND" qualifier to better refine the search results. In this case, our initial search used the keywords "core stability" AND "low back pain." As of February 21, 2013, this search yielded 22 articles. Other search term combinations yielded much greater numbers: "Exercise" AND "low back pain" had 2,171 results; "stabilization exercises" AND "low back pain" gave 129 results; "motor control" AND "exercise" provided 71 results; and "core stabilization exercises" AND "low back pain" gave only 24 results.

If the search results yield many articles, look for the best-quality ones. Here are some features to help determine good quality:

1. Recent publication
2. Peer-reviewed publication
3. High-level research. Not as many articles are available at the higher level because they are summaries of what is available in the lower levels. Therefore, higher-level research papers are dependent on good quality in the field research, such as case series and RCTs. Here is the Hierarchy of Evidence,[18,19] with the best listed first:
    a. Meta-analysis (statistical analysis of qualified studies)
    b. Systematic Reviews (critical evaluation of similar subject studies)
    c. Randomized Controlled Trials (aka RCTs, clinical trials comparing randomly assigned participants into various groups)
    d. Cohort Studies (studies of a specific participant base)
    e. Case Series (presents findings from multiple case reports on a similar subject)
    f. Case Reports (summary of a specific clinical case)

From the search of "core stability" AND "low back pain," these are the top-quality publication results (in order of publication and then by ranking):

1. A meta-analysis in 2012 by Wang, et al. compared core stability exercises and general exercise for chronic low-back pain. The literature review demonstrated that the core exercises were better at reducing pain (95% confidence interval [-2.47, -0.1]; p=0.003) and at reducing disability (95% confidence interval [211.64, 22.65]; P = 0.002) in the short-term follow-up. However, there were apparently no significant differences at 6 and 12 months.[20]

2. An RCT by Hides in 2011 studied the effects of bed rest on low-back pain as well as demonstrated how specific motor-control (SMC) training without generating compressive forces through the spine was better than trunk flexor and

general strength (TFS) training at restoring lumbar multifidi strength.[9]

3. A systematic review by Chou in 2007 evaluated 10 systematic reviews and 10 RCTs, comparing the effectiveness and safety of various interventions in the treatments of chronic low-back pain. It demonstrated that exercise improved pain and function when compared with other conservative treatments.[21]

4. The systematic review by Hauggaard that was included in the 2007 Chou study is of even higher quality for the PICO question for this patient because it examined 7 RCTs in terms of how effective specific stabilization exercises helped LBP. This review demonstrated that there was moderate evidence that specific stabilization exercises improved disability and/or pain level and increased the multifidi cross-sectional area and that there was only limited evidence of improved quality of life after treatment.[22]

5. Upon further evaluation of the Hauggaard study, one of the RCTs evaluated compared how LBP patients responded when specific exercise therapy was added to medical management and normal daily activities vs. not having added exercise therapy. The results demonstrated that control patients were 12.4x more likely to have LBP recurrence within 1 year and 9x more likely to have it in 2-3 years.[23] Although this study does not specifically match the patient description because it was in first-time LBP sufferers, the fact that it compared exercise vs. nothing and did so by random assignment of the participants qualifies this article as a good one.

From these results, it appears that core exercises would be good for my patient. The next question is, Which exercises should be given and when? By using the "Related citations in PubMed" suggestions list on PubMed and looking more closely at the references of the good-quality articles, I found a couple of useful articles that summarized and prescribed what the core muscles are and which core stability exercises are best to use. The constant was that not all exercises work for all LBP patients.[5,22,24] However, movement in itself provides extra therapeutic benefits, such as better mood, better kinesthetic awareness, and increased flexibility (thus less risk of reinjury), along with better cardiovascular health.[25]

The exercises should work within the patient's intolerances (positions or activities that exacerbate the problem) and biases (positions or activities of relief) and avoid putting further loads on healing tissues.[4,11] Spinal stabilization exercises have been studied in terms of how much compressive load they have on the lumbar spine compared with the degree of stability they provide. The lowest spinal compression with moderate stability gain can be achieved by doing the supine bridge or 4-point kneeling with 1 leg lift (essentially the "Bird Dog" without the pointing). The Bird Dog, which involves a cross-crawl movement of the arm and leg, demonstrated higher stability but at a higher compressive load. The exercises that provided moderate stability, while having a higher compression, were the abdominal curl, side bridge, and bridge with 1 leg extended.[7]

How can the chiropractor implement and sequence the exercises?

The best exercise and stretch programs are ones that the patient will actually do. Keep it simple, make it fun, keep it low tech, and adapt it to the patient's needs and self-perceptions. Although swimming is an excellent full-body exercise that increases aerobic capacity as well as tones and stretches the whole body, if the patient doesn't like swimming or doesn't have easy access to a pool, she will not be compliant.

Here are some guidelines:[4]

1. Posture endurance training should be done daily;
2. Aerobic exercise such as daily walking increases endurance training effects;
3. Work within the patient's biases (encourage these) and intolerances (avoid these);
4. Increase quantity only when quality is mastered;
5. Change the exercises when boredom sets in or the exercises become easy;
6. Increase time before number of repetitions;
7. Progress when ready, but don't leave the basics behind;
8. Mindfulness in abdominal bracing during activities of daily living (ADL) prevents injury.

Most of the concepts and exercises that were ultimately given to my patient are very simply explained by McGill in his 2003 article on the Ace Fitness website called "Enhancing Low-back Health Through Stabilization Exercise."[26] Here are the exercises and instructions that were used daily with this patient:

Week 1

1) McGill Curl Up[26] (A mini-crunch in which the supine patient has 1 leg flat and 1 leg bent with a foot on the floor and her hands, palms down, under her low back. She then pushes against the floor with her elbows and lifts her chest up while maintaining a neutral neck.) - hold for 5 seconds, repeat 10x (5 with right leg bent, 5 with left leg bent).
2) Side Bridges - hold for 5 seconds, repeat 10x per side.
3) Avoid lumbar flexion – avoid sitting as much as possible to allow for healthy scarring to begin. Try modifications such as using a raised workstation and standing when writing or using a computer or lying down when reading.
4) Walk around as much as possible between stationary activities to help maintain healthy blood flow.

Week 2

1) Continue Week 1 exercises, but increase time and repetitions by doubling them and adding the following:
2) Dead Bug- Wall Push for abdominal bracing training (rib cage tucks). Hold for 5-10 seconds, rest 10 seconds, do 3-5x.
3) Front Plank (on elbows)- hold for 5-10 seconds, rest 10 seconds, do 3-5x.
4) Bird Dog- do alternating arms and hands for 10-20 count. (Do these slowly, and make sure to maintain good form.)

Week 3

1) Continue Week 2, and add the following:
2) Dead Bug- Wall Push- with heel taps- for 10-20 count (quality of form is essential)
3) Half-depth lunges- 5 per leg
4) Half squats, making sure to bend at the hips "hip hinge" and not flex the spine- 5x

Week 4

1) Continue Week 3, and add the following:
2) Plank Roll Overs (front, side, front, other side) at 8-second count per position- 5x
3) Pelvic Oscillations (while maintaining the abdominal brace, move the hips side to side (salsa hips) and in horizontal circles). These are to engage the spinal segmental muscles and to encourage proprioception and position sense training. Start with small movements, and progress to larger movements in different directions and patterns.

Although my patient entered into these exercises with some trepidation, she felt the results were excellent. Within 1 week, she was able to hold a side bridge bilaterally and perform a front plank. When she did the McGill Curl Up, her back felt relief so she quickly overcame her fear avoidance, which no doubt helped a great deal in her healing and progression. It took more than 1 month for her to return to normal activities of daily living and to high-impact aerobics. She continues to avoid prolonged flexion and has a daily routine of doing the "McGill Big 3" (the McGill Curl Up, Side Plank, and Bird Dog),

Plank Roll Overs, and Pelvic Oscillations. She has had no major low-back pain episodes since.

Makani Lew, BSc, DC, is an associate professor at Palmer College of Chiropractic's West Campus in San Jose, California. Dr. Lew maintains a resources blog for her students and the general public at http://freetofeelhealthy.blogspot.com/. *She can be reached by email at* lew_m@palmer.edu.

References

1. Ohio State University Medical Center. Dead bug exercises patient education handout. *Department of Rehabilitation Services, The Ohio State University Medical Center* 2004 Sept. Retrieved on February 23, 2013, from the following website: https://ckm.osu.edu/sitetool/sites/sportsmedicinepublic/documents/OSU_MC_patient_education/back_neck/dead-bug-exer.pdf.
2. Hyman J and Liebenson C. Chapter 14: Spinal stabilization exercise program. In: Liebenson C. *Rehabilitation of the Spine: A Practitioner's Manual,* 1st ed. Philadelphia: Lippincott Williams & Wilkins;1996:293-317.
3. Hodges PW, Richardson CA. Delayed postural contraction of transversus abdominis associated with movement of the lower limb in people with LBP. *J Spinal Disord* 1998;11(11):46-56.
4. McGill SM. Chapter 10: Building better rehabilitation programs for low back injuries. In: Low Back Disorders: *Evidence-based Prevention and Rehabilitation,* 2nd ed. Champaign: Human Kinetics Publishers; 2007:166-88.
5. Barr KP, Griggs M, Cadby T. Lumbar stabilization: core concepts and current literature, Part 1. *Am J Phys Med Rehabil* 2005;84:473-80.
6. Akuthota V, et al. Core stability exercise principles. *Curr Sports Med Rep* 2008;7(1):39Y44.
7. Kavcic N, Grenier S, McGill SM. Quantifying tissue loads and spine stability while performing commonly prescribed low back stabilization exercises. *Spine* 2004;29:2319-29.
8. Hides JA et al. Evidence of lumbar multifidus muscle wasting ipsilateral to symptoms in patients with acute/subacute low back pain. *Spine* 1994;19(2):165-72.
9. Hides JA et al. The effects of rehabilitation on the muscles of the trunk following prolonged bed rest. *Eur Spine J* 2011;May;20(5):808-18.
10. Roy SH, DeLuca CJ, Casavant DA. Lumbar muscle fatigue and chronic low back pain. *Spine* 1989;14(9):992-1001.
11. Hicks GE, Fritz JM, Delitto A, McGill SM. Preliminary development of a clinical prediction rule for determining which patients with low back pain will respond to a stabilization exercise program. *Arch Phys Med Rehabil* 2005; 86:1753-62.
12. Dedering A, Harms-Ringdahl K, Nemeth G. Back extensor muscle fatigue in patients with lumbar disc herniation: Pre-operative and post-operative analysis of electromyography, endurance time and subjective factors. *Eur Spine J* 2006;15:559-69.
13. Arab AM et al. Sensitivity, specificity and predictive value of the clinical trunk muscle endurance tests in low back pain. *Clinical Rehabilitation* 2007; 21:640-47.
14. McGill SM, Childs A, Liebenson C. Endurance times for low back stabilization exercises: clinical targets for testing and training from a normal database. *Arch Phys Med Rehabil* 1999;80:941-4.
15. McGill SM. Chapter 11: Evaluating the patient. In: *Low back Disorders: Evidence-based Prevention and Rehabilitation,* 2nd ed. Champaign: Human Kinetics Publishers; 2007:189-212.
16. Gatterman MI. Chapter 16: Spinal cord mechanisms of referred pain and related neuroplasticity. In*: Foundations of Chiropractic: Subluxation,* 2nd ed. St Louis: Elsevier Mosby; 2005:351.

17. Cramer GD and Darby SA. Chapter 11: Pain of spinal origin. In: *Basic and Clinical Anatomy of the Spine, Spinal Cord, and ANS*, 2nd ed. St. Louis: Elsevier Mosby; 2005:480-517.
18. Nordenstrom J. *Evidence-based Medicine: In Sherlock Holmes' Footsteps*. Malden, MA: Blackwell Publishing Ltd; 2007.
19. Guyatt G et al. Chapter 2: The philosophy of evidence-based medicine. In: Users' guide to the medical literature. *JAMA*; 2008:9-16.
20. Wang X et al. A meta-analysis of core stability exercise vs. general exercise for chronic low back pain. *PLoS One* 2012;7(12):e52082.
21. Chou R. Low back pain (chronic). *Clin Evid (Online)* 2010;Oct 8;pii:1116.
22. Hauggaard A, Persson AL. Specific spinal stabilisation exercises in patients with low back pain: a systematic review. *Phys Ther Rev* 2007;12:233–48.
23. Hides J et al. Long-term effects of specific stabilizing exercises for first-episode low back pain. *Spine* 2001;26:E243-E248.
24. Barr KP, Griggs M, Cadby T: Lumbar stabilization: a review of core concepts and current literature, Part 2. *Am J Phys Med Rehabil* 2007;86:72–80.
25. Rainville J et al. Exercise as a treatment for chronic low back pain. *The Spine Journal* 2004;4:106-15.
26. McGill SM. Enhancing low-back health through stabilization exercise. *ACE Certified News* 2003;February/March:3-6. Retrieved February 21, 2013, from this website: www.acefitness.org/pdfs/LowBackStabilization.pdf.