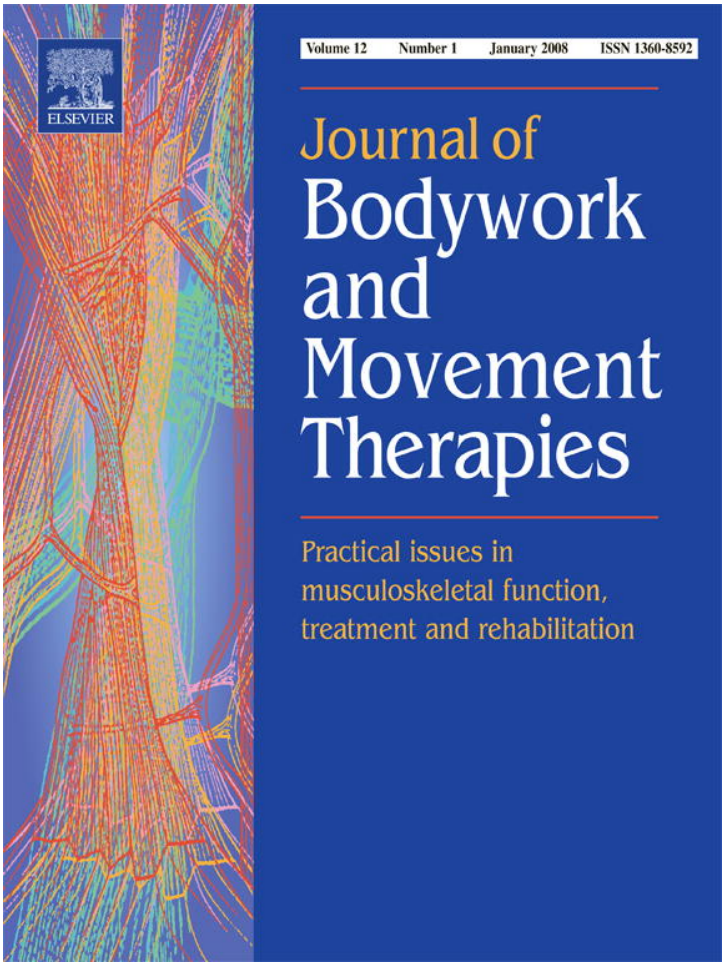

Journal of Bodywork and Movement Therapies (2008) **12**, 31–36

ELSEVIER

Journal of
**Bodywork and**
**Movement Therapies**

www.intl.elsevierhealth.com/journals/jbmt

SELF-MANAGEMENT: CLINICIAN SECTION

# A modern approach to abdominal training—Part III: Putting it together ☆

**Craig Liebenson, DC***

*L.A. Sports and Spine, 10474 Santa Monica Blvd., #202, Los Angeles, CA 90025, USA*

Received 15 October 2007; accepted 28 October 2007

## Introduction

Training the abdominal wall is one of the most popular exercise goals in health maintainance and rehabilitation. Our understanding of how best to activate the abdominal musculature for fitness promotion, performance enhancement, injury prevention, or rehabilitation is evolving rapidly. The intention of this three part series is to provide an update on the current state of knowledge in this area.

Part one of this series summarized the importance of motor control in modern abdominal training. Abdominal training myths involving voluntary exercise training in general and sit-ups in particular were discussed. The importance of muscle co-activation patterns as a means to stabilize the spine and the evidence of effectiveness for spine stability abdominal training programs has been reviewed.

Part two of this series described in detail a specific technique called the abdominal brace. The clinical value and application of the abdominal brace in stability exercise programs was presented. This third part of the series will review the basics of a modern abdominal stability program. Specifically, what the main exercises are that can "groove" appropriate motor control and movement control in the spine.

## Safe back exercises

Training the abdomen should be done in a way that is safe for the spine. Demanding activities of daily living (ADL) involve loads of approximately 6000 N and the NIOSH work demand limit is 6400 N (McGill, 1998; Panjabi, 1992). Elite weight lifters manage, through highly skilled motor control strategies, to safely lift loads of nearly 20,000 N (McGill, 1998). Routine ADLs involve approximately 2500 N, thus a safe limit of approximately 3000 N is recommended for subacute exercise training (McGill, 1998; Panjabi, 1992). Ideal exercises should challenge the muscles of the core while imposing minimal compressive load on the spine (Axler and McGill, 1987; McGill, 1995; McGill et al., 1996). These include the side bridge, bird–dog, and dying bug. Other exercises that would not spare the spine of an acute or subacute patient would include sit-ups, curl-ups on a ball, or the prone superman. Table 1 lists a number of exercises with both safe and unsafe load profiles for subacute back pain patients.

Maintaining a safe load profile during exercise training is a cornerstone of exercise prescription for

☆This paper may be photocopied for educational use.

*Tel.: +1 310 470 2909; fax: +1 310 470 3286.
*E-mail address:* cldc@flash.net

1360-8592/$ - see front matter © 2007 Published by Elsevier Ltd.
doi:10.1016/j.jbmt.2007.10.005

**Table 1** Exercise profiles (Axler and McGill, 1987; McGill, 1995, 1998; McGill et al., 1996).

| Safe exercises | Unsafe exercises |
|---|---|
| • Quad single leg raise: 2000–2300 N<br>• Opposite arm/leg raise: ≈3000 N<br>• Side bridge on knees: <2000 N<br>• Side bridge on ankles: 2600 N<br>• Curl-up: 2000 N | • Sit-ups bent knee: 3350 N<br>• Sit-ups straight knee: 3500 N<br>• Curl up on ball: 4000 N<br>• Prone superman: 4300 N |

the subacute low back pain patient. Other factors that should be considered include maintaining the ''neutral lordosis'' posture, the abdominal brace, and cardio-respiratory fitness or coordination of breathing with abdominal activity (Cholewicki and McGill, 1996; Cholewicki et al., 2005; Gardner-Morse and Stokes, 1998; Granata and Marras, 2000; McGill et al., 1995). Incoordination in elite weight lifters whereby they fail to control lumbar lordosis has been shown to precipitate spinal injury (Cholewicki and McGill, 1996). Involuntary abdominal and back muscle co-contraction is an important back stabilizing function (Cholewicki et al., 2005; Gardner-Morse and Stokes, 1998; Granata and Marras, 2000). Such co-contraction involves all the muscles encircling the lumbar spine in particular the oblique abdominals (Grenier and McGill, 2007). Active co-contraction or abdominal bracing has been shown to stabilize the spine during specific voluntary tasks (e.g. leg raising) (Liebenson et al., 2007). Fatigue during weight lifting has been shown to disturb the coordination between breathing and abdominal muscle contraction, thus compromising low back stability (McGill et al., 1995).

## McGill's ''Big 3''

Begin with a warm-up and then perform exercises 8–10 times for one set. When this can be accomplished easily more sets can be added using the Reverse Pyramid approach of performing a few less repititions with each subsequent set (e.g. 1st set—15 reps; 2nd set—12 reps; 3rd set—8 reps) (McGill, 2007). It is crucial that good form is maintained during all exercises. Sacrificing the quality of the movement to achieve greater quantity is a good way to cause injury. A summary of basic principles is given in Table 2.

**Table 2** Stability training variables (modified from Liebenson, 2007).

- *Intensity*: submaximal, less than 50% of single repetition maximum (1RM)
- *Sets and repetitions*: start with 1 set of approximately 6 reps
  - Progress to 1 set of 15 reps
    Further progress following the reverse pyramid approach of adding a 2nd set of 12 reps then a 3rd set of 8 reps
- *Hold times*: emphasize endurance by holding for one to two breaths (6–10 s)
- *Form*: movements should be performed slowly with appropriate form for motor control training and injury prevention
- *Frequency*: daily or twice a day to improve motor control
- *Duration*: up to 3 months required to reeducate movement patterns in a chronic patient

Other than the cat–camel which is used during a warm-up all the other exercises are used to improve motor patterning and endurance. During these exercises a few fundamental principles should be observed. The spine should always be neutral (e.g. slight lordosis). Normal respiration should be maintained (avoid holding the breath or always timing exertion with exhalation). The abdominal brace should be maintained to keep the spine reasonably stiff. And, the thoraco-lumbar junction should be held in a neutral position—avoid hyperextension or kyphosis—by moving the anterior ribs inferiorly.

## Warm-up

Always warm-up before performing ''core'' exercises. The cat–camel performed 8–10 times slowly is the ideal warm-up (see Figure 1). It should be carried out gently with the mind-set to limber the spine not to stretch it.

## Side bridge

The side bridge can be performed with hips and knees flexed (see Figure 2). The goal is to extend through the hips rather than the spine while elevating the torso. This should be thought of as a hip hinge or squat exercise performed on the side.

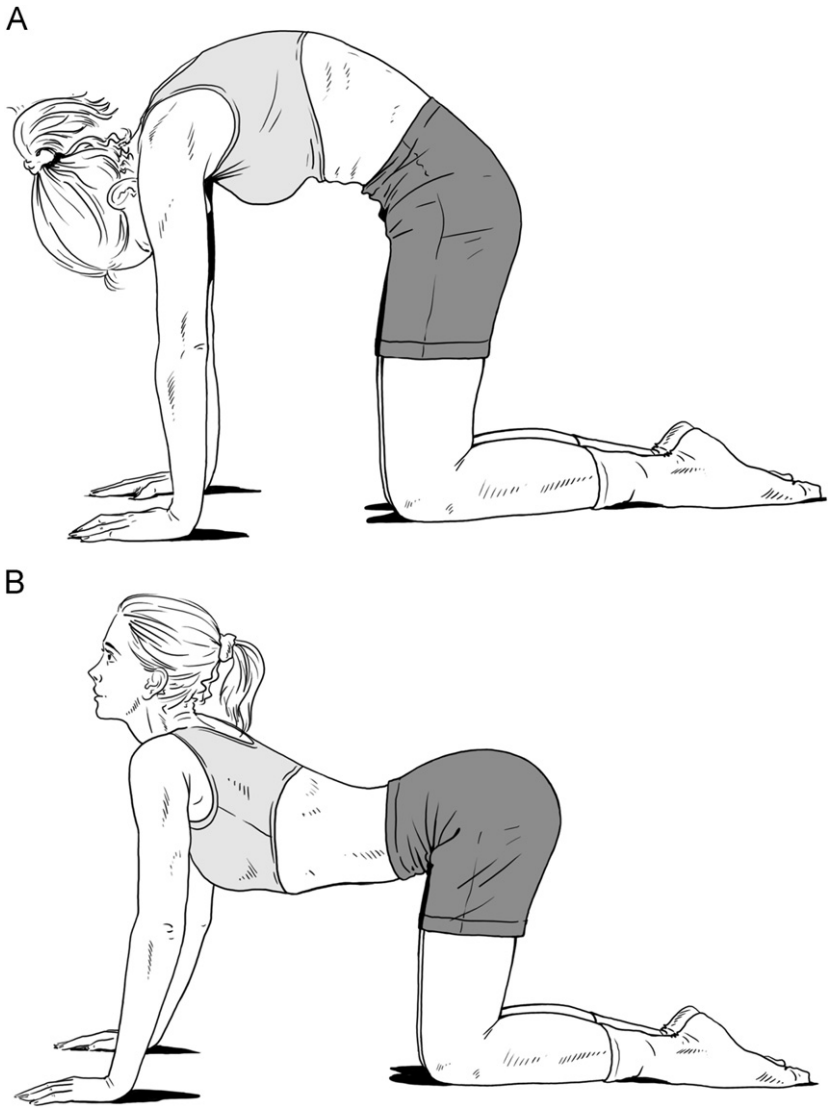


**Figure 1** Cat–camel. Reproduced with permission from Liebenson (2007).

## Bird–dog

The bird–dog is performed with a neutral spine (slight lordosis) and mobilization of the opposite arm and leg with the torso completely stabilized (see Figure 3). Cervico-cranial, scapulo-thoracic, thoraco-lumbar, and lumbo-pelvic posture should all be observed for "neutral" range control.

## Dying bug

The dying bug begins on one's back with arms and legs elevated. For a basic version the opposite arm and leg are moved together and then apart while maintaining stability in the torso (see Figure 4). Most importantly, the anterior inferior ribs should be maintained in the "exhalation" or caudal position. This will stabilize the thoraco-lumbar junction.

## Goal setting

An individual's lifestyle goals should always be identified first. Then an evaluation of functional capacity is the next step. The gap between a person's capacity and goals is what training should bridge. The reason for this is that if a person's internal functional capacity falls short of their external physical demands an injury will result.

As an example an elite athlete will have more demanding goals than a sedentary person. Thus, the training will have to result in a greater

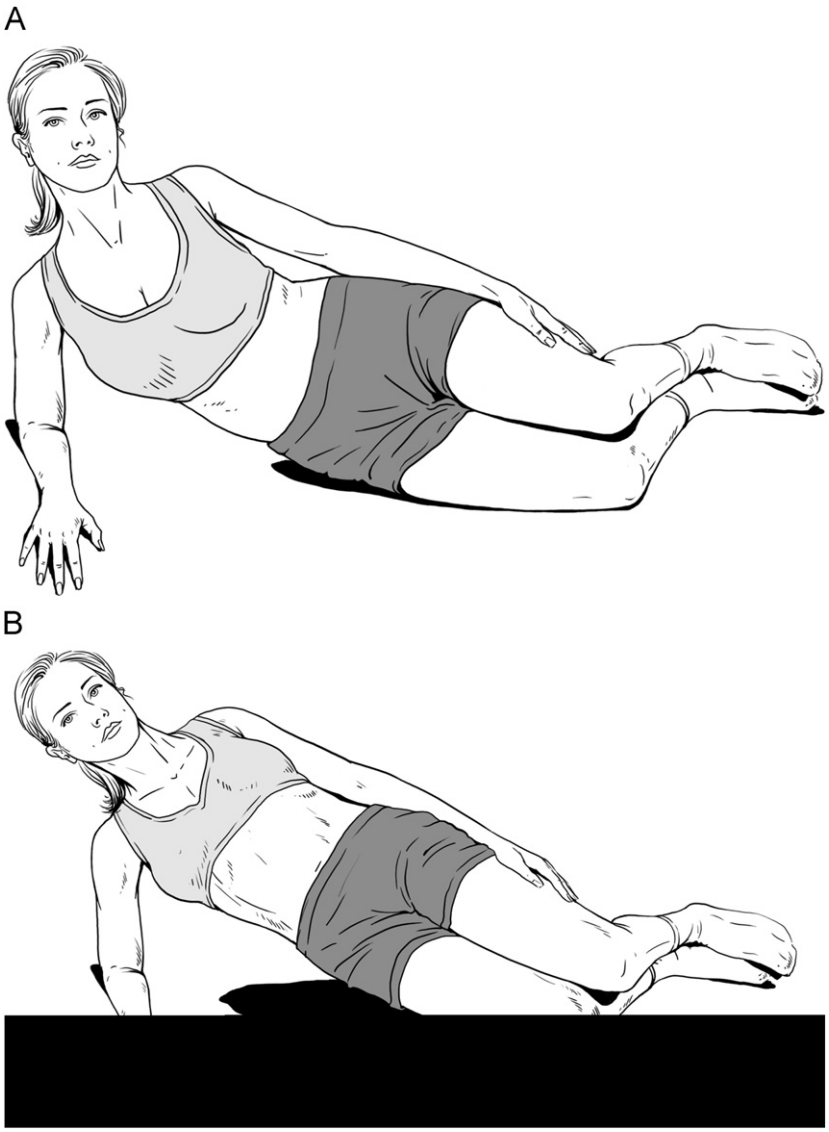


**Figure 2** Side bridge. Reproduced with permission from Liebenson (2007).

**Figure 3** Bird–dog. Reproduced with permission from Liebenson (2007).

individual functional capacity. However, a sedentary person, weekend warrior or elite athlete may all have equally large gaps. It is just that the athlete's are skewed towards the higher performance end of the spectrum (see Figure 5).

The ultimate goal of care is to restore optimal function to enhance participation without limitations in ADLs. The specific goal is to identify a successful self-management routine, which allows for resumption of social activities with

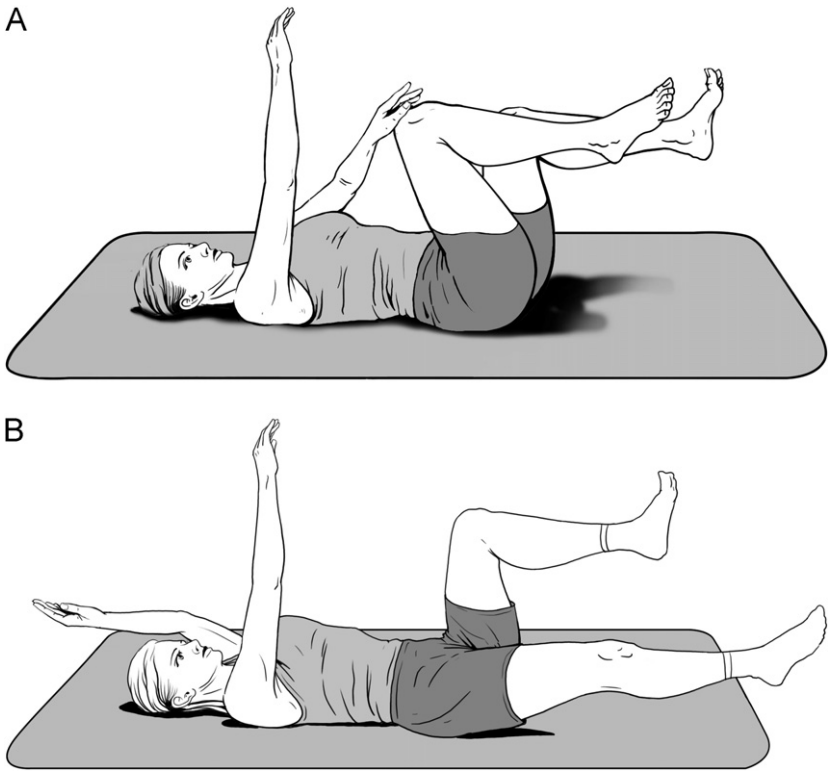


**Figure 4** Dying bug. Reproduced with permission from Liebenson (2007).

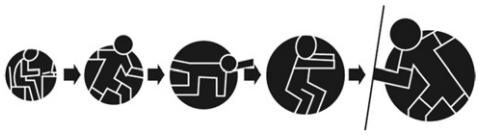

**Figure 5** Functional–performance continuum. Reproduced with permission from Liebenson (2007).

a pre-episode activity tolerance. A supervised rehabilitation program is prescribed until a "functional training range" (FTR) can be established. This is the range of exercises which is

(a) tolerated
(b) does not aggravate symptoms during or after their performance
(c) reduces or centralizes symptoms and improves function

Once the FTR is established the supervised routine is progressed to semi-supervised training. The end-point of care is achieved when a self-management, autonomous routine is as effective as the supervised care. According to Morgan (1988), "After the patient has learned the limits of his or her functional range, conditioning and training for ADL can safely begin… The patient must develop the coordination to control and feel the back position. Such coordination must become second nature so that the habit is maintained during all activities ...."

When training a person to achieve higher capacity the exercises should be as functional as possible. This means they should mimick as much as possible the activities which they perform. It is also critical that exercises both reduce pain and enhance function. A clinical audit process (CAP) should be utilized to assure both clinician and patient that the exercises are within the patient's FTR. This is the range which is "painless and appropriate for the task at hand" (Morgan, 1988). After exercising re-test any movements that were previously found to be uncomfortable. By using the CAP patients can be reassured that mild pain with exercise did not equate with harm and that actually the exercises are therapeutic.

The initial goal is always to find exercises, which the patient tolerates. Such "graded exposures" to potentially threatening activities are used with the CAP to reassure the patient and dispell any beliefs the patient has that hurt equals harm. As the patient progresses it becomes more important to "groove" coordinated motor patterns. The final step is to challenge patients at the same level or even to a higher level than they will face in their home, job, recreational, or sports activities. This will provide a sufficient stability margin for error.

## Summary

Core exercise should be both safe and effective. Motor control exercise emphasizes increasing a patient's functional capacity to eclipse the demands of their activities. Therefore, it should be as functional as possible. Such a program requires little in the way of costly equipment. However, clinical supervision is required to weed out form issues and to determine the specific routine, which reduces the patients pain and restores their activity tolerance.

## References

Axler, C.T., McGill, S.M., 1987. Low back loads over a variety of abdominal exercises: searching for the safest abdominal challenge. Medical Science of Sports Exercise 29, 804–810.

Cholewicki, J., McGill, S.M., 1996. Mechanical stability of the in vivo lumbar spine: implications for injury and chronic low back pain. Clinical Biomechanics 11 (1), 1–15.

Cholewicki, J., Silfies, S.P., Shah, R.A., et al., 2005. Delayed trunk muscle reflex responses increase the risk of low back injuries. Spine 30 (23), 2614–2620.

Gardner-Morse, M.G., Stokes, I.A.F., 1998. The effects of abdominal muscle coactivation on lumbar spine stability. Spine 23, 86–92.

Granata, K.P., Marras, W.S., 2000. Cost-benefit of muscle cocontraction in protecting against spinal instability. Spine 25, 1398–1404.

Grenier, S.G., McGill, S.M., 2007. Quantification of lumbar stability by using 2 different abdominal activation strategies. Archives of Physical Medicine and Rehabilitation 88, 54–62.

Liebenson, C., 2007. Rehabilitation of the Spine: A Practitioner's Manual, second ed. Lippincott/Williams & Wilkins, Philadephia.

Liebenson, C., Karpowicz, A.M., Brown, S.H., Howarth, S., McGill, S.M., 2007. The active straight leg raise test and lumbar spine stability. Journal of Manual Therapy, submitted for publication.

McGill, S., 1995. The mechanics of torso flexion: situps and standing dynamic flexion manouvres. Clinical Biomechanics 10, 184–192.

McGill, S.M., 1998. Low back exercises: prescription for the healthy back and when recovering from injury. In: Resources Manual for Guidelines for Exercise Testing and Prescription, third ed. American College of Sports Medicine, Indianapolis, IN, Williams and Wilkins, Baltimore.

McGill, S.M., 2007. Ultimate Back Fitness and Performance, third ed. Backfitpro Inc., Waterloo, Canada.

McGill, S.M., Sharratt, M.T., Seguin, J.P., 1995. Loads on the spinal tissues during simultaneous lifting and ventilatory challenge. Ergonomics 38, 1772–1792.

McGill, S.M., Juker, D., Kropf, P., 1996. Quantitative intramuscular myolectric activity of the quadratus lumborum during a wide variety of tasks. Clinical Biomechanics 11 (3), 170–172.

Morgan, D., 1988. Concepts in functional training and postural stabilization for the low-back-injured. Topics in Acute. Care and Trauma Rehabilitation 2 (4), 8–17.

Panjabi, M.M., 1992. The stabilizing system of the spine. Part 1. Function, dysfunction, adaptation, and enhancement. Journal of Spinal Disorders 5, 383–389.