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Jason Brumitt
George Fox University, jbrumitt@georgefox.edu

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CASE REPORT

Successful rehabilitation of a recreational endurance runner: Initial validation for the Bunkie test

Jason Brumitt, MSPT, SCS, ATC, CSCS, Assistant Professor of Physical Therapy*

Pacific University Oregon, 222 SE 8th Avenue, Hillsboro 97123, OR, USA

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Summary This case report details the musculoskeletal evaluation and the successful rehabilitation of a 24-year-old female recreational distance runner who self-referred to physical therapy with an acute bout of low back pain (LBP). Her LBP was provoked during each distance run. The patient's musculoskeletal evaluation revealed core weakness, especially on the left. A recently reported functional test, the Bunkie test, was administered as part of the physical evaluation. The scores from the Bunkie test correlated with other quantitative and qualitative findings. A therapeutic exercise program emphasizing core stabilization was prescribed. The patient was able to shortly return to running pain-free.

Millions of individuals run for exercise and/or sport each year. Some of the health benefits potentially associated with regular aerobic exercise (*e.g.* running) include improvements in cardiopulmonary function, muscular strength, and body composition. In addition, regular aerobic exercise may aid in the prevention or management of chronic diseases. However, despite the reported health benefits associated with aerobic exercise, distance runners risk injury to the lumbar spine and the lower extremities (Duffey et al., 2000; Fredericson et al., 2000; Klossner, 2000; Taunton et al., 2002, 2003; Gunter and Schwellnus, 2004; Barr and Harrast, 2005; Kennedy et al., 2005; Paluska, 2005; Cosca and Navazio, 2007). Risk factors associated with sports-related running injuries are frequently categorized by anatomical variants, running biomechanics, and training patterns (Bennett et al., 2001; Hreljac, 2005; Reinking and Hayes, 2006; Rauh et al., 2007). Appreciating these risk factors will help the practitioner to prescribe interventions to an at risk distance runner and improve the rehabilitation professional's ability to evaluate and treat the injured runner. While strides have been made to identify injury risk factors, there are some risk factors (*e.g.* the runner's anatomy) that are not amenable to conservative treatments. There is also

* Tel.: +1 503 352 7265; fax: +1 503 352 7340.
E-mail address: brum4084@pacificu.edu

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Figure 1 Posterior power line.

Figure 3 Posterior stabilizing line.

disagreement in the literature as to the significance of each individual risk factor (Lun et al., 2004; Schache et al., 2005; Reinking and Hayes, 2006).

Recent reports suggest "core" weakness may contribute to the onset of a sport related injury (Fredericson et al., 2000; Niemuth et al., 2005). The core may be defined as the anatomical region of the body consisting of the joints and muscles of the trunk (abdominals, spine, and pelvis), the hips, and the proximal lower extremities (Kibler et al., 2006). Trunk and hip musculature play a significant role in maintaining optimal lower extremity biomechanics (Powers, 2003, 2010; Fredericson and Moore, 2005; Hollman et al., 2006). Failure of the trunk and/or hip musculature to stabilize proximal segments while running may affect optimal lower extremity biomechanics during the stance phase contributing to a low back or lower extremity injury (Powers, 2003, 2010; Fredericson and Moore, 2005; Hollman et al., 2006).

Several tests have been reported to quantitatively or qualitatively measure core function (McGill, 2002; Plastaras et al., 2005). These "functional tests" are reported to reveal dysfunctional movement patterns, range of motion asymmetries, and/or muscular imbalances. de Witt and Venter (2009) have recently introduced the Bunkie test as a tool to assess the function of the core muscles along fascial lines. The Bunkie test consists of 5 testing positions (Figures 1—5) performed bilaterally (de Witt and Venter, 2009). de Witt and Venter (2009) suggest that either asymmetrical or deficient test scores will help the rehabilitation specialist identify dysfunction and guide treatment. Using their clinical experience, de Witt and Venter suggest that endurance athletes should maintain each test position for at least 40 s (de Witt and Venter, 2009).

The purpose of this case report is to highlight the successful rehabilitation of a recreational endurance athlete who experienced an acute bout of low back pain. This report will detail the clinical findings from the patient's musculoskeletal evaluation and provide initial validation for the Bunkie test.

Case description

A 24-year-old female graduate school student self-referred to the university's physical therapy clinic with a month long episode of low back pain associated with distance running. She reported that she experienced left-sided low back pain (visual analog scale 5—6 out of 10) during each distance run. Each time she attempted a run, her pain would limit

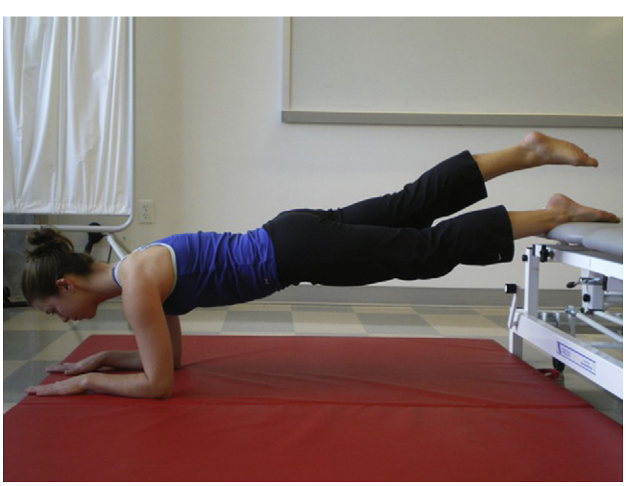

Figure 2 Anterior power line.

Figure 4 Lateral stabilizing line.

Figure 5 Medial stabilizing line.

Table 1 Manual muscle test scores (0—5 scale) measured during the initial evaluation.

Muscle group	Right side	Left side
Gluteus maximus	5	3+ with symptom provocation
Gluteus medius	5−	3+
Hip external rotators	4	3+
Hip internal rotators	5	4+
Hip flexors	5	5
Hip adductors	5	5

her ability to complete her typical training distance of 2—4 miles. After each run, her pain would continue for "the next couple of days". Once her pain subsided, she would attempt a distance run again, which was accompanied by symptom provocation. She reported that no other activity reproduced her pain. Except for low back pain, her medical history was otherwise unremarkable.

Table 3 Bunkie test scores measured during the initial evaluation.

Test position	Right side (s)	Left side (s)
Posterior power line	12 (patient experienced symptom reproduction during testing)	30
Anterior power line	22	44
Posterior stabilizing line	18	10
Lateral stabilizing line	53	18
Medial stabilizing line	16	13

Physical examination

Standing examination

Posture, active lumbar range of motion (AROM), and lower extremity movement patterns were assessed in standing. The patient demonstrated full, pain-free lumbar active range of motion in all planes. Her static posture appeared unremarkable when viewed from all sides.

Two functional tests were conducted to assess the patient's dynamic lower extremity movement patterns (Manske et al., 2003). Functional tests, such as the squat and the lunge, may reveal dysfunctional movement patterns or functional weakness (Manske et al., 2003). No significant dysfunctional movement patterns were noted when she performed the squat. She did however demonstrate dysfunction when performing the lunge. When lunging, each lower extremity demonstrated a medial collapse (*e.g.* hip internal rotation and adduction, knee valgum, and tibial internal rotation). This medial collapse was observed bilaterally; however, to a greater degree when the left lower extremity lunged forward.

Seated examination

In sitting, a neurologic screening exam and selected manual muscle tests were administered. Lumbar myotomes

Table 2 Findings associated with table examination.

Patient position	Manual muscle test	Special test	Palpation
Supine	n/a	1. Thomas test: symmetrical 2. Leg length: symmetrical in supine and long-sitting 3. Knee to Chest: (-) bilaterally 4. Straight Leg Raise: (-) and symmetrical bilaterally to 90° 5. FABERE: (-) bilaterally	No pain experienced with palpation.
Side-lying	Gluteus medius (abduction): (R) 5−/5; (L) 3+/5	Obers test: (-) bilaterally	No pain experienced with palpation.
Prone	Gluteus maximus (extension): (R) 5/5; (L) 3+/5 with symptom provocation	Ely's test: (-) bilaterally	Tender to palpation: 1. Left PSIS 2. Left lumbar facets L4—L5

Table 4 Bunkie test positions and the associated regions of the body reported to be tested in each position (de Witt and Venter, 2009).

Bunkie test position	When the right leg is on the bench...
Posterior power line	The low back and the posterior and lateral muscles/fascia of the left lower extremity is reported to be assessed
Anterior power line	The abdominals and the anterior and lateral muscles/fascia of the left lower extremity is reported to be assessed
Posterior stabilizing line	The posterior and medial muscles/fascia of the right lower extremity is reported to be assessed
Lateral stabilizing line	The lateral muscles/fascia of the right lower extremity is reported to be assessed
Medial stabilizing line	The medial muscles/fascia of the right lower extremity is reported to be assessed

(L2—S1), lumbar dermatomes (L2—S1), and lumbar reflexes (L3 and S1) were intact bilaterally. Traditional manual muscle tests (MMT) were performed for hip internal and external rotation, hip flexion, and knee extension. Table 1 presents selected manual muscle test scores.

Table examination

AROM, MMT for the gluteus maximus and gluteus medius, and special tests were performed on a treatment table with the patient positioned in supine, prone, and side-lying. In supine, AROM for the hips were symmetrical and within normal limits. In prone, the patient presented with 3+/5 strength (and experienced symptom reproduction during

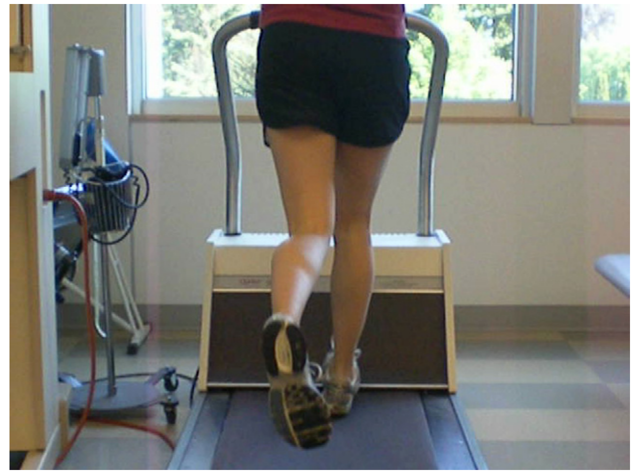

Figure 7 Hip internal rotation and adduction on the left.

the MMT) in her left gluteus maximus. During the initial MMT for the left gluteus maximus, she utilized a compensatory strategy by activating her hip adductors. Table 2 presents the findings from each test performed on the table.

Bunkie test

The Bunkie test was administered as previously described by de Witt and Venter (2009). Figures 1—5 depict the 5 testing positions. The bench was adjusted to a height of approximately 25 cm for the patient in this case (de Witt and Venter, 2009). Table 3 presents the patient's scores (recorded in s) for each test. Table 4 provides a summary of which region of the body a particular test is reported to assess (de Witt and Venter, 2009). For example, when testing the posterior power line, de Witt and Venter (2009) contend that when the right leg is on the bench the low back and the posterior and lateral muscles and fascia of the left lower extremity are assessed (Table 4). The patient's scores from the Bunkie test (right side posterior power line, right side anterior power line, left side posterior stabilizing line, left side lateral stabilizing line, left side medial

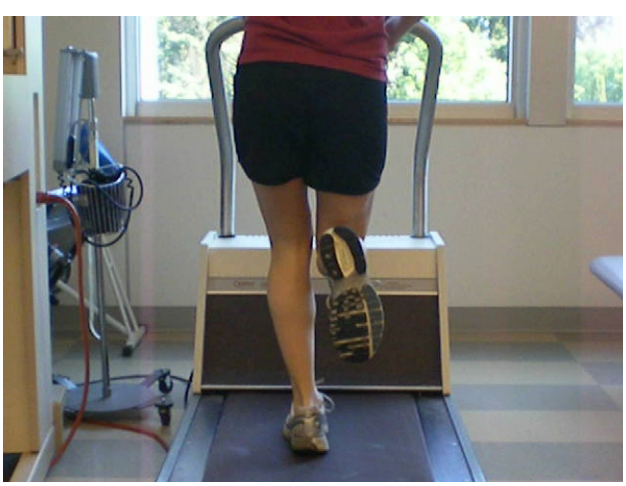

Figure 6 Positive trendelenburg on the left.

Figure 8 Left thigh adduction.

Table 5 Therapeutic exercise program.

Exercise	Purpose	Sets/Reps
Clamshell	Performed by the patient for 2 days to facilitate gluteus medius activation	2 sets × 15 reps performed bilaterally
Prone hip extension (with knee flexed to 90°)	To initiate strengthening for the gluteus maximus	1 set × 15 reps performed bilaterally
Side-lying straight leg raise (hip abduction)	To strengthen the gluteus medius	2 sets × 15 reps performed bilaterally
Front planks	To improve core endurance	2 sets × 10 s holds
Side planks	To improve core endurance	2 sets × 10 s holds performed bilaterally

stabilizing line) correlated with the aforementioned muscular weakness identified during MMT.

Running assessment on treadmill

A posterior view of the client running on a treadmill was recorded using a digital camera. A review of the video revealed two biomechanical errors that were frequently repeated throughout the assessment period. Figure 6 illustrates a positive Trendelenburg sign on the left. Figures 7 and 8 illustrate the left lower extremity adducting toward or crossing midline during the swing phase.

Summary of findings

The low back pain that the patient experienced during a distance run was assessed to be the result of muscular weakness of her core, especially the muscles of the left hip. The inability to proximally stabilize impaired her lower extremity alignment and function when running. As a result, she experienced abnormal tissue loads in the left lumbar region above that of her tissue's tolerance (McGill, 2002).

The physical therapy evaluation identified weakness in the gluteus maximus and gluteus medius on the left side. This core weakness was noticeable during a functional movement such as the lunge (medial collapse left side greater than the right side). Her scores on the Bunkie test were below the recommended scores for an endurance athlete (de Witt and Venter, 2009). In addition, the patient demonstrated asymmetrical scores with lower scores recorded during the Bunkie testing positions that assessed the left lower quadrant.

The objective findings from the physical examination correlated with the qualitative assessment of her running mechanics. She demonstrated a positive Trendelenburg sign (indicative of a weak or inhibited gluteus medius) and faulty running mechanics during the toe off and swing phase on the left. Due to her weak or inhibited left gluteus maximus, she was unable to maintain her left hip and thigh in relative abduction and external rotation (Fredericson et al., 2000; Niemuth, 2007). In addition, it appears that the patient activated her left hip adductors to assist with propulsion on the left in response to her functionally weak gluteus maximus. Neumann (2010) explains that with the thigh internally rotated and adducted (poor proximal stabilization with the gluteus medius), the hip adductors are positioned to provide hip extension. As a result, it may be that the lower extremity was adducted from toe off and was maintained in some degree of adduction through the swing phase on the left.

Treatment

Treatment consisted of therapeutic exercises to address core weakness (Table 5). Specific exercises were directed

Figure 9 Prone hip extension exercise.

Figure 10 Side plank exercise.

Figure 11 Front plank exercise.

toward improving activation and strength of the gluteus medius (clamshells and side-lying straight leg raise) and the gluteus maximus (prone leg extension (Figure 9)). Side and front planks (Figures 10 and 11) were prescribed to improve endurance capacity of the core. Upon follow-up, the patient was prescribed side planks with hip abduction, front planks with hip extension, and lunges to her home exercise program.

Follow-up

The patient returned to physical therapy 8 days later. At this point she reported that she had resumed her typical running distance pain-free. The Bunkie test was administered again with the patient demonstrating improvements in all of testing positions (Table 6). Due to her functional improvements and her improved pain score with running (VAS 0/10) the patient was discharged from physical therapy. During an informal follow-up 4 months later, the patient reported that she had been able to run pain-free for all of her training distances.

Discussion

This case highlights musculoskeletal testing considerations for a recreational distance runner with a low back injury and the successful rehabilitation program that addressed the pertinent findings from the examination. Functional tests were administered as part of the musculoskeletal evaluation. It has been suggested that a functional test (or series of tests) may be useful as an assessment tool to identify weakness or dysfunctional activation of the core muscles (Nadler et al., 2001; McGill, 2002). The recently described Bunkie test was utilized to highlight weakness in the patient's core. To the best of the author's knowledge the only other report in the literature discussing the Bunkie is the original report by de Witt and Venter (2009).

This case report provides an initial validation for the Bunkie test. de Witt and Venter (2009) contend that these 5 tests performed bilaterally assess the function of the core along fascial lines. Future studies are necessary to support the author's aforementioned claims (the testing of fascial lines). However, the findings from this case report suggest that the Bunkie test may help identify muscular imbalances between core muscle groups. In addition, the patient's initial Bunkie test scores correlated with the findings from the traditional manual muscle tests. Future research is necessary to identify normative data, to identify which muscle(s) are being assessed during each test position (electromyography), and prospective epidemiological designs to determine the ability of the Bunkie test to identify individuals at risk for injury. Currently, despite the number of functional tests reported to assess core function, there is paucity in the literature to support potential clinical value. Future testing is necessary to identify either the best test or tests to assess core function and to predict injury risk.

This case report also adds to the growing body of literature supporting the role of therapeutic exercises addressing core dysfunction in runners. Brumitt et al. (2009) included exercises for the core as part of a comprehensive rehabilitation program for an injured and iron-deficient division-III female collegiate cross-country athlete. During the course of her cross-country season she set school records and earned All-American status (Brumitt et al., 2009). Wagner et al. (2010) successfully treated a 42-year-old male triathlete whose performance had been affected by recurrent right hamstring cramping. The patient was able to return to sport, completing triathlons without symptom provocation (Wagner et al., 2010). The inclusion of core exercises in a healthy client's training program may aid performance and reduce injury risk. Core exercises were included in a successful return to running training program for a postpartum client (Brumitt, 2009). After an 8-week course of training, the client had returned to running and realized improvements in core strength (Brumitt, 2009).

Table 6 Comparison of Bunkie test scores (s) at baseline and 8 days later.

Test position	Right side scores at baseline	Left side scores at baseline	Right side scores at follow-up (8 days later)	Left side scores at follow-up (8 days later)
Posterior power line	12	30	59	52
Anterior power line	22	44	37	52
Posterior stabilizing line	18	10	24	23
Lateral stabilizing line	53	18	56	38
Medial stabilizing line	16	13	23	16

Conclusion

Core weakness may be a contributing factor in the onset of a runner's low back pain. For some clients, assessing the muscular strength and endurance capacity of their core with functional tests may reveal significant dysfunction. The scores from the Bunkie test in this case correlated with other quantitative tests and qualitative findings. Future research investigations of the Bunkie test are warranted to establish demographic data and to determine test reliability.

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