CORE STABILITY:
PRIORITIES IN REHABILITATION OF THE ATHLETE

By Mark Comerford, MCSP

The development of strength and stability training programmes for sport has been a priority in the attempt to optimise performance and accelerate the post-injury rehabilitation process. To date, attempts to do this have mainly centred on testing and regaining joint range, muscle strength (both power and endurance) and muscle extensibility. Some attempts have focused on developing functional tests and retraining programmes based on sport-specific skills.

Most of these training programmes end up becoming ‘protocols’ for ‘core stability’ training or ‘protocols’ for a particular injury; such as a patellar malalignment protocol, a shoulder instability protocol or a post-surgical protocol. Some of the benefits of a protocol-based training regime is that it can be designed with clear goals, performance targets, structured time frames and the protocol can be readily disseminated to a large number of people. The developers of these protocols have the unenviable task of producing a programme that is simple and at the same time comprehensive enough to deal with the wide range of variability in patient presentation and complications. It is difficult for one protocol to cover the time-frame from injury to return to competitive sport. One of the weaknesses with protocol-based training programmes is that there has to be an assumption that all people who use the protocol have, to a large extent, the same problem. Most protocols are designed along a linear framework. That is, there are a series of linear progressions from one skill or stage to the next. Consequently, in the attempt to account for individual differences in participant presentation (especially if injury and pathology is involved) many of these protocols are modified or adapted, often many times over.

The primary problem then with protocol-based training programmes is that they are forced to become ‘recipes’. The recipe works well for one particular goal or a ‘classic’/‘textbook’ presentation of a problem, but therapists and trainers who regularly work with injured athletes know that they rarely present as the textbook case. They all have their own differing variations, complications and expectations. What is needed is a paradigm shift towards a process of systematic assessment and analysis that can be used to guide rehabilitation of dysfunction and retraining of performance deficits. It should be based on a systematic assessment of an individual’s ‘weak links’ and lead to the development of a client-specific retraining programme to more appropriately address the real priorities in injury rehabilitation and performance training. The retraining programme is designed along a multidimensional and parallel framework, rather than a linear recipe.

It is well accepted in today’s professional sporting environment that power, endurance and flexibility are important and are a necessary and integral part of any sports training programme. McGill (1), Chek (2) and many other rehabilitation specialists and strength and conditioning trainers advocate high-load power and endurance training as the end goal of the retraining process and base their training programmes and protocols around strengthening the core and limbs to increase core stability and sporting performance. They eloquently argue the relationship between force and power and stability. However, there is an under representation (if present at all) of low-load motor control training in many of these training programmes. If low-load motor control training is used it is often presented as part of a linear progression along the path to achieve high load strengthening.

Hodges (3) argues that strengthening the muscles of range and force potential is one process while training the deeper (force inefficient) muscles of motor control is a distinctly separate process. Both are required to perform to high levels of activity such as competitive sport. One analogy for this is to think of the musculoskeletal system as a computer. High speed or high-load strength training changes muscle structure and can be likened to upgrading the computer’s hardware. This can make the computer work faster and run more complex programs. Low-threshold motor control training doesn’t change the muscle structure to any great extent, but instead improves the central nervous system’s ability to fine tune muscle co-ordination and improve the efficiency of movement. This is like upgrading the software in a computer to perform its tasks more efficiently and to get the most out of the hardware already present. Pain is like a computer virus, which primarily affects the software causing the computer to run slowly and crash more often. In the human body pain has more consistent effects on the motor control aspects of movement rather than directly affecting muscle structure.

Contemporary neurophysiological and clinical research into movement dysfunction associated with musculoskeletal injury, chronicity and recurrence of injury, highlight deficits of low-threshold muscle recruitment and motor control inefficiency (4-16). These deficits are only clinically and functionally identified with very specific tests of low-load recruitment efficiency. Some of these dysfunctions develop prior to the onset of symptoms and injury and appear to be precursors or contributing factors to the development of injury and symptoms (9,12). There is mounting evidence that failure of low-load recruitment efficiency is a consistent and reliable predictor of recurrence (6,17).

www.sportex.net
# CORE STABILITY

## TABLE 1. STABILISER AND MOBILISER MUSCLE ROLES (12.18.19)

<table>
<thead>
<tr>
<th>STABILISER ROLE CHARACTERISTICS</th>
<th>MOBILISER ROLE CHARACTERISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>One joint (mono-articular)</td>
<td>Two joint (bi-articular or multi-segmental)</td>
</tr>
<tr>
<td>Broad aponeurotic insertions (to distribute and absorb force and load)</td>
<td>Superficial (longer lever, larger moment arm and greatest bulk)</td>
</tr>
<tr>
<td>Leverage for load maintenance, static holding and joint compression</td>
<td>Unidirectional fibres or tendinous insertions (to direct force to produce movement)</td>
</tr>
<tr>
<td>Postural holding role associated with eccentrically decelerating or resisting momentum (especially in the axial plane - rotation)</td>
<td>Leverage for range and speed and joint distraction</td>
</tr>
<tr>
<td></td>
<td>Repetitive or rapid movement role and high strain/force loading</td>
</tr>
</tbody>
</table>

## TABLE 2. LOCAL AND GLOBAL MUSCLE ROLES (20.21)

<table>
<thead>
<tr>
<th>LOCAL MUSCLE SYSTEM CHARACTERISTICS</th>
<th>GLOBAL MUSCLE SYSTEM CHARACTERISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deepest, 1 joint</td>
<td>Deep 1-joint or superficial multi-joint</td>
</tr>
<tr>
<td>Minimal force/stiffness</td>
<td>Force efficient</td>
</tr>
<tr>
<td>No or minimal length change</td>
<td>Concentric shortening to produce range</td>
</tr>
<tr>
<td>Does not produce or limit range of motion</td>
<td>Eccentric lengthening or isometric holding to control range</td>
</tr>
<tr>
<td>Maintains background motor control in all ranges, all directions</td>
<td>No translation control</td>
</tr>
<tr>
<td>No antagonists</td>
<td>Direction specific/antagonist influenced</td>
</tr>
</tbody>
</table>

## TABLE 3. LOCAL MOTOR CONTROL ROLE

- Muscle stiffness to control segmental translation
- No or minimal length change in function movements
- Anticipatory recruitment prior to functional leading provides protective stiffness
- Activity is continuous and independent of the direction of movement (eg. transversus abdominis, segmental lumbar multifidus, posterior fasciculus of psoas major)

## TABLE 4. GLOBAL STABILITY ROLE

- Generates force to control/limit range of movement
- Functional ability to (i) shorten through the full inner range of joint motion (ii) isometrically hold position (iii) eccentrically control the return
- Low threshold eccentric deceleration of movement (rotation)
- Activity is non-continuous and is direction dependent (eg. external obliqueus abdominis, superficial multifidus iliacus)

## TABLE 5. GLOBAL MOBILITY ROLE

- Generates force to produce range of movement
- Concentric acceleration of movement (sagittal plane - power)
- High load shock absorption
- Activity is especially phasic (on/off pattern) and is direction dependent (eg. rectus abdominis, iliocostalis, rectus femoris, hamstrings)

www.sportex.net
MUSCLE CATEGORISATION
The concepts of stabiliser and mobiliser muscle roles (see table 1) and local and global muscle systems (see table 2), provide useful frameworks to classify muscle function. However, alone, these models have some deficiencies.

By inter-linking these two concepts a useful model of muscle functional roles can be developed (9,21) where muscles can be categorised as having three functional roles:

i) a local stability role (table 3)
ii) a global stability role (table 4)
iii) a global mobility role (table 5).

CORE STABILITY
The core is best represented as a double walled cylinder consisting of the lower back and abdomen and the upper back and chest (the trunk) (22,23).

The inner wall of the core cylinder is made up of the deep local muscle system (inner core). These muscles include:

- respiratory diaphragm
- transversus abdominis
- segmental multifidus
- posterior psoas
- pelvic floor

The outer wall of the core is made up of the outer global muscle system (outer shell). These consist of the muscles which have a global stability role along with the muscles having a global mobility role. These muscles influence postural alignment and contribute to the production and control of range of motion. The global stabilisers here include the oblique abdominals, superficial multifidus and spinalis, anterior psoas, oblique fibres of quadratus lumborum and contributions from the pelvic floor.

The 'core' also consists of the pelvic and shoulder girdles. The scapula provides a mechanical linkage between the arms and the trunk, while the pelvis provides the link between the legs and the trunk.

In normal function the limbs and trunk often counter rotate relative to each other and these rotation forces are co-ordinated and controlled at the two girdles.

The global outer shell frequently develops muscle imbalance where various global mobiliser muscles become dominant and 'take over' from the stabiliser muscle function or create restrictions resulting in compensatory movement patterns.

REHABILITATION

MOTOR CONTROL STABILITY VERSUS STRENGTH
Motor control stability assessment is based on the accepted and extensive research on muscles like transversus abdominis. Stability function (or dysfunction) is reliably tested under low-load situations. It is based on the ability to pass or fail a low threshold test of motor recruitment. The benefit of having good stability function of both the local and global stabiliser muscles is in improved low threshold motor control and in decreasing mechanical musculo-skeletal pain (Figure 2).

- Pass - no movement induced pathology and pain free function
- Fail - development of pathology and pain.

Muscle strength is measured as the ability to pass or fail a test of resisting or supporting a high load. The grading of muscle strength as 1 to 5 with manual muscle testing is an example of muscle strength testing that physiotherapists are trained to perform. This testing is often performed using force dynamometers to provide more objective measurements. The benefit of having good strength is that performance is improved or maintained. Strength training does not demonstrate consistent improvement in pain and pathology or low threshold motor control function (see figure 2).

- Pass - good power, endurance and high load performance

Definitions and terminology
Because the term 'core stability' no longer is used in the way it started off, and it has now achieved generic status in the exercise and fitness industry it is necessary to differentiate and re-define stability concepts.

- The term 'core stability' is now used to describe exercises that range from an almost imperceptible activation of the deep abdominal muscles to lifting weights overhead while balancing on an inflatable physio ball.
- The term 'motor control stability' may be an appropriate new label for low threshold stability concepts and is best defined as central nervous system modulation of efficient integration and low threshold recruitment of local and global muscle systems.
- 'Core strength training' may be more appropriate for high threshold or overload strength training of the global stabiliser muscle system.

www.sportex.net
CORE STABILITY

- ‘Symmetrical strength training’ may be more appropriate for the more traditional high threshold or overload strength training of the global mobiliser muscle system.

There are some defining differences between ‘motor control stability’ and ‘core strengthening’ (see table 6).

In contrast, symmetrical or traditional strength training has certain differences and benefits.
- High threshold training (muscle adapting to overload demand)

<table>
<thead>
<tr>
<th>TABLE 6: DIFFERENCES BETWEEN MOTOR CONTROL STABILITY AND CORE STRENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MOTOR CONTROL STABILITY</strong></td>
</tr>
<tr>
<td>Muscle specific: That is, training can be biased for either a local stabiliser muscle or a global stabiliser muscle.</td>
</tr>
<tr>
<td>Recruitment specific: That is, because all these exercises use low load or functional normal loads then slow motor units are predominately recruited</td>
</tr>
<tr>
<td>Central nervous system modulated: That is, afferent spindle input influences tonic motor output (‘software upgrade’).</td>
</tr>
</tbody>
</table>

- Biased for the global mobiliser muscles
- Sagittal plane prevailing (+/- coronal plane)
- The need to control a rotation challenge or load is eliminated
- Predominantly isotonic with emphasis on concentric (also isometric and isokinetic)

CORE STABILITY SUMMARY

Core stability now encompasses a large range of exercise processes. These processes include:
- a) local muscle system motor control
- b) global muscle system motor control
- c) strength training of the core (trunk)
- d) symmetrical or traditional strengthening of the trunk and limbs using limb loading (22, 24).

The similarities and differences between these different processes can be analysed under several different headings (see table 7):

- Activation threshold: Low threshold (non-fatiguing low load) and high threshold (fast movement or fatiguing high load)
- Muscle emphasis: The muscle functional role predominantly emphasised or trained (local stability or global stability or global mobility role)
- Position or direction of primary loading: eg. local stabilisers work independently of direction so no specific direction is loaded. Global stabilisers control all directions of motion (especially rotation). So, in motor control training these muscles are trained to resist all directions trunk movement against low functional loads, while in core strength training they are trained to resist high load rotation challenges. In symmetrical or traditional strength training the muscles with the greatest biomechanical potential to lift the heaviest load are the global mobilisers and they do this best if rotation can be eliminated from the exercise
- Type of contraction: Isometric holding of contraction to resist movement strain or isotonic contraction involving emphasis of the shortening against load (concentric) or lengthening to control or decelerate load (eccentric)
**TABLE 7: THE SIMILARITIES AND DIFFERENCES BETWEEN THE DIFFERENT EXERCISE PROCESSES (22,24)**

<table>
<thead>
<tr>
<th></th>
<th>SYMMETRICAL ‘TRADITIONAL’ STRENGTHENING (LIMBS)</th>
<th>CORE STRENGTHENING (TRUNK)</th>
<th>MOTOR CONTROL STABILITY (GLOBAL)</th>
<th>MOTOR CONTROL STABILITY (LOCAL)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activation threshold</strong></td>
<td>High Global stabilisers Flexion-extension: symmetrical/sagittal loading +/- side bend +/- abduction-adduction (no axial rotation control) (rotation eliminated)</td>
<td>High Global stabilisers Neutral position: asymmetrical loading (axial rotation) +/- rotation resistance +/- rotation through range (rotation challenged)</td>
<td>Low Global stabilisers Neutral position and dissociate all three planes especially rotation control but including flexion and extension control (three directions)</td>
<td>Low Local stabilisers Neutral position (no direction)</td>
</tr>
<tr>
<td><strong>Muscle emphasis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Position/direction of 1° Loading</strong></td>
<td>Isotonic: move limbs and trunk through range (concentric)</td>
<td>Isotonic: resist trunk motion Isotonic: move trunk through rotation (concentric)</td>
<td>Isotonic: resist trunk motion (dissociation)</td>
<td>Isotonic: move limbs through range (isometric hold in shortened range and eccentric lowering)</td>
</tr>
<tr>
<td><strong>Type of contraction</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on the evidence to date, high threshold re-training (traditional strengthening and core strengthening) does not appear to correct motor control dysfunction in the local stability system (5,25). However, specific low threshold training does appear to correct local and global motor control stability dysfunction (17,26,27). Low load training does not appear to correct high threshold dysfunction or atrophy (28,29). Both the local and global muscle systems must integrate together for efficient normal function (3.9). Both low threshold and high threshold function are required for return to manual work or sport (22,24,30).

**TRAINING GUIDELINES**

Table 8 highlights the key elements that provide the guidelines to train one process or another.

**TABLE 8: KEY ELEMENTS OF TRAINING FOR EACH EXERCISE PROCESS (22)**

<table>
<thead>
<tr>
<th>Guidelines for training</th>
<th>SYMMETRICAL ‘TRADITIONAL’ STRENGTHENING (LIMBS)</th>
<th>CORE STRENGTHENING (TRUNK)</th>
<th>MOTOR CONTROL STABILITY (GLOBAL)</th>
<th>MOTOR CONTROL STABILITY (LOCAL)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>fatiguing high load exercise</td>
<td>fatiguing high load exercise</td>
<td>non fatiguing low load exercise</td>
<td>non-fatiguing low load exercise</td>
</tr>
<tr>
<td></td>
<td>+/- speed</td>
<td>+/- speed</td>
<td>unilateral or asymmetrical limb or trunk load</td>
<td>trunk does not move out of neutral</td>
</tr>
<tr>
<td></td>
<td>bilateral or symmetrical limb load</td>
<td>unilateral or asymmetrical limb or trunk load</td>
<td>trunk does not move out of neutral</td>
<td>allow slight global stabiliser co-activation</td>
</tr>
<tr>
<td></td>
<td>no rotation challenge</td>
<td>high rotation challenge</td>
<td>dissociate rotation, flexion and extension</td>
<td>discourage global dominance</td>
</tr>
<tr>
<td></td>
<td>limb or trunk lifting in the flexion-extension plane</td>
<td>resist rotation force at trunk</td>
<td>emphasise rotation control at trunk and girdles</td>
<td>discourage core ‘rigidity’</td>
</tr>
<tr>
<td></td>
<td>allow global mobiliser dominance</td>
<td>rotate trunk against resistance</td>
<td>shortened range hold for postural control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>encourage core ‘rigidity’</td>
<td>discourage global mobiliser dominance</td>
<td>discourage core ‘rigidity’</td>
<td></td>
</tr>
</tbody>
</table>

www.sportex.net
CORE STABILITY

Examples of these concepts and guidelines in practice

Abdominal muscle training examples can be used to illustrate the application of these concepts and guidelines.

Example 1
Local motor control stability: Transversus abdominis (Figure 3)

Pull in or ‘hollow’ the lower abdominal wall (especially the lateral aspect) without excessive overflow to the upper abdominal wall. This ‘drawing in’ action should be isolated to lower muscular region and should attempt to minimise spinal or rib cage movement and not cause lateral flaring of the waist.

Example 2
Global motor control stability: External oblique abdominis (Figure 4)

Slowly lift one foot off the floor and then lift the second foot off the floor and bring it up beside the first leg. Use this position with hips flexed to 90° and both feet off the floor as the starting position. Place one hand under the back to monitor back stability. Hold this position and keeping the back stable (no pressure change on hand), pull the lower and upper abdominal wall in towards the spine. Slowly lower one heel to the floor and lift it back to the start position. Repeat this movement, slowly alternating legs for 10 seconds so long as stability is maintained (no pressure change), and then return both feet to the floor. Repeat the whole process 10 times.

Setting note: as soon as any pressure increase or decrease is registered the movement must stop and return to the resting position (feet on floor). The point of greatest risk of losing stability is when the heel is lowering to the floor. Do not allow bracing or fatigue.

Example 3
Core strengthening: Co-contraction of all abdominals with the obliques emphasised (Figure 5)

Slowly lift one foot off the floor and then lift the second foot off the floor, and bring it up beside the first leg. (Use this position with hips flexed to 90° and both feet off the floor as the starting position). Place one hand under the back to monitor back stability. Pull the lower and upper abdominal wall in towards the spine. Hold this position and keeping the back stable (no pressure change) slowly lower one heel to just above the floor and extend it out into extension unsupported. As soon as any pressure change or movement of the back or pelvis is registered the movement must stop and move back in to the rest position. The leg may extend as far as stability is maintained (no pressure change). Repeat this movement, slowly alternating legs, for 10 seconds, and then return both feet to the floor. Repeat the whole process until fatigue makes it difficult to maintain the stable lumbo-pelvic position. Do not allow loss of position due to fatigue.

Example 4
Symmetrical ‘traditional’ strengthening: Co-contraction of all abdominals with the rectus abdominis emphasised (Figures 6 and 7)

Start in crook lying and tighten the anterior abdominals to flatten the back and posterior tilt the pelvis. Then actively lift the head and shoulders by sliding the hands up the thighs to flex the trunk and shorten rectus abdominis. Sustain the hold in this position for 10 seconds and slowly unroll down maintaining the posterior tilt. Repeat the whole process until fatigue makes it difficult to maintain the hold for 10 seconds.

Progress by lying supine with the legs out straight and feet unsupported. With the arms above shoulder height the patient actively posteriorly tilts the pelvis and lifts the head and shoulders to flex the trunk fully. Then, while maintaining the posterior tilt and trunk flexion the hips flex to lift the trunk over the pelvis and roll up to a sitting position. Sustain this position for a few seconds and then slowly unroll down, keeping the posterior tilt. Stop and hold half-way for 10 seconds before curving up again. Hold the curl up for a few seconds then unroll to half-way again. Repeat the whole process until fatigue makes it difficult to maintain the half-way hold.
CLINICAL INDICATIONS
In the clinical scenario there appears to be an assumption that rehabilitation and stability retraining must start with local motor control training and progress in a linear framework through global motor control then to core strengthening and finally to high-end symmetrical traditional strengthening. There is no evidence in the research literature to support this notion of structured linear progression. Individuals present to the clinic with different symptoms and injuries that cause varying levels of disability and impairment. By taking a thorough case history and performing an examination that assesses each of the four elements of core stability for deficiencies or ‘weak links’ a multi-factorial picture of the problem becomes clear. Based on current biomechanical and physiological understanding of movement function and dysfunction, clinical anecdotal evidence and sound clinical reasoning, some specific clinical indications for prioritising different ‘weak links’ can be suggested (31).

INTEGRATION OF ‘CORE’ STABILITY SYSTEMS
There are many differing interpretations of stability and stability training. With increasing demands on therapists for therapeutic exercise programmes it is often difficult to know where to start. Core stability is a term that encompasses a variety of differing training processes that affect the stability, efficiency, performance and symptoms within the movement system. By analysing and prescribing exercise based on this framework (Figure 8), it is possible to move away from the idea of stability and performance training being a linear progression from low threshold motor control training to high loads strength training.

BOX 1: INDICATIONS FOR LOW LOAD TRAINING OF THE LOCAL SYSTEM AS A CLINICAL PRIORITY
1. Relevant symptom presentation:
   a. associated with low load normal daily function
   b. non direction specific pain
   c. associated with static position and all postures (sit, stand and lying)
2. Uncontrolled compensatory articular translation
3. History of insidious recurrence (prevention)
4. Poor voluntary low threshold recruitment efficiency
   - Pain in the region

BOX 2: INDICATIONS FOR LOW LOAD TRAINING THE GLOBAL SYSTEM AS A CLINICAL PRIORITY
1. Relevant symptom presentation:
   a. associated with low load normal daily function
   b. direction specific pain - associated with a particular direction of movement provocations
2. Direction related mechanical pain (one movement ≠ symptoms and another movement ≠ symptoms)
3. Low threshold recruitment imbalance between stabilisers (inefficient/force inhibited) and mobilisers (dominant/overactive)
4. Length – tension imbalance between stabilisers (long/force inefficient inner range) and mobilisers (lack extensibility)
5. History of recurrence - usually related to a precipitating incident where a specific direction of stress or strain is implicated in the mechanism of injury (prevention?)
   - Non-symptomatic uncontrolled (direction specific) ‘give’ (it may be possible to prevent onset or minimise risk)

BOX 3: INDICATIONS FOR HIGH LOAD TRAINING THE LOCAL SYSTEM AS A CLINICAL PRIORITY
Core strength training
1. Relevant symptom presentation:
   a. unilateral pain
   b. only associated with high load activity (not associated with low load normal daily function or postures)
   c. direction specific pain - associated with a particular direction of movement provocation
   d. symptoms provoked with asymmetrical activity
2. Atrophy (disuse) or load related weakness
3. Rotation ‘give’ under high load testing:
   a. with unilateral or asymmetrical (rotational) load
   b. with bilateral or symmetrical (sagittal) load

BOX 4: INDICATIONS FOR HIGH LOAD TRAINING THE GLOBAL SYSTEM AS A CLINICAL PRIORITY
Symmetrical ‘traditional’ strength training
1. Relevant symptom presentation:
   a. midline pain
   b. only associated with high load activity (not associated with low load normal daily function or postures)
   c. direction specific pain - associated with a particular direction of movement provocation
   d. symptoms provoked with symmetrical or sagittal (flexion/extension) activity
2. Atrophy (disuse) or load related weakness
3. Sagittal (flexion or extension) ‘give’ under high load testing:
   a. with bilateral or symmetrical (sagittal) load
   b. with unilateral or asymmetrical (rotational) load

www.sportex.net
CORE STABILITY

Therapeutic exercise prescription should be based on a process of assessment of where the real weak links in function and performance lie and then the rehabilitation or performance training programme should be devised to train different weak links in parallel with individually assessed starting points and progressions based on correcting relevant dysfunctions and achieving predetermined levels of performance.

If there is at least a clear understanding of the differences between symmetrical/traditional strength training, core strength training and local and global ‘motor control’ stability training then therapists, rehabilitation specialists, exercise physiologists, coaches and trainers are in a better position to make a thorough assessment of dysfunction related to symptoms and performance and make more reasoned clinical decisions regarding the appropriate type of intervention. Then it will become possible to advance from the era of protocol-based rehabilitation and performance training for the athlete.

THE AUTHOR
Mark Comerford MSc, B.Phys, MAPA graduated from the University of Queensland, Australia in 1980. He worked for seven years as a senior musculoskeletal physiotherapist and in 1987 started teaching in the Physiotherapy Department at the University of Queensland for the undergraduate and postgraduate programmes, lecturing in electrotherapy, sports physiotherapy and therapeutic exercises. In 1992 he moved to the UK and established postgraduate courses in dynamic stability and muscle balance. This process evolved into Kinetic Control of which Mark is the senior director. Mark continues to teach and present throughout the UK and Europe, Australia, USA and Canada. He has moved back to Australia but continues to deliver courses through Kinetic Control and Performance Stability across the world.

Performance Stability is a training company which delivers first class core stability and performance training courses to professionals in the sports, health and fitness industries. Performance Stability courses focus on the evidence-based Performance Matrix, which is a unique and simple method of high and low stability assessment and retraining which can be used to find and fix weak links in an individual’s functional performance chain. For more information visit www.performance-stability.com or see the advertisement on the back inside cover.

References
10. Gibbons SG, Comerford MJ. Strength versus stability - part 1 concept and terms. Orthopaedic Division Review 2001(a);March/April:21-27
18. Goff B. The application of recent advances in neurophysiology to Miss R Rood’s concept of neuromuscular facilitation. Physiotherapy 1972;58:2 409-415
22. Comerford MJ. Core stability training: the performance matrix. Performance Stability Course Kinetic Control UK 2004 (b)
24. Comerford MJ. Core Stability for Return to Work and Return to Sport. Kinetic Control Movement Dysfunction Course Kinetic Control UK 2004(a)
30. Comerford MJ. What comes first - The pain or the dysfunction? - Integration of local and global stability systems in rehab Proceeding 1st International Conference on Movement Dysfunction Edinburgh UK 2001
31. Comerford MJ and Mottram SL. The Integration of Dynamic Stability and Muscle Balance Concepts into Clinical Problem Solving: Kinetic Control Movement Dysfunction Course Kinetic Control UK 2004(b)