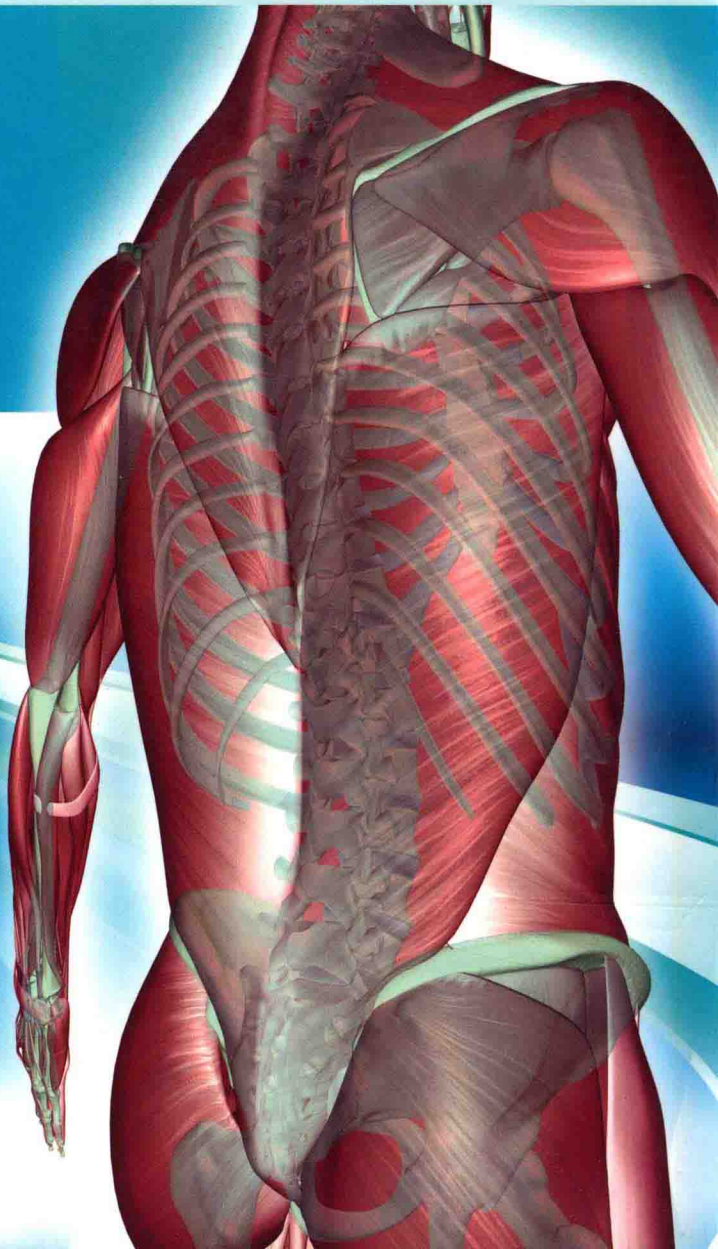
KINETIC CONTROL

The Management of Uncontrolled Movement

Mark Comerford
Sarah Mottram



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Mark Comerford, BPhty, MCSP, MAPA

Director, Movement Performance Solutions

Sarah Mottram, MSc, MCSP, MMACP

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Preface

This book presents a comprehensive system for the assessment and retraining of movement control. It has been in evolution for the last 25 years.

Uncontrolled movement has a significant impact on the development of movement disorders and pain. The scientific support for the process of the assessment and retraining of uncontrolled movement has been steadily expanding particularly in the last 10 years. The influence of uncontrolled movement on symptoms, especially pain, movement function, recurrence of symptoms and disability is now well established. We believe that in the next 10 years the literature will support that the presence of uncontrolled movement will also be recognised as a predictor of injury risk and as having an influence on performance.

Uncontrolled movement can be identified by movement control tests. People with pain demonstrate aberrant movement patterns during the performance of these movement control tests. A growing body of evidence supports the use of movement control tests in the assessment and management of chronic and recurrent pain. The identification of uncontrolled movement in terms of the site, direction and threshold of movement impairment is a unique subclassification system of musculoskeletal disorders and pain. The movement testing process proposed enables the classification of uncontrolled movement into diagnostic subgroups that can be used to develop client-specific retraining programs. This process can determine management priorities and optimise the management of musculoskeletal pain and injury recurrence. Subclassification is now recognised as being the cornerstone of movement assessment and the evidence for subclassification of site, direction and threshold is growing. This book details a structured system of testing, clinical reasoning and specific retraining. This system does not preclude other interventions as it is designed to enhance the management of musculoskeletal disorders.

The Kinetic Control process has come a long way in last 25 years. The motivation for the development of the Kinetic Control process was to find a way to blend the new and exciting concepts in movement dysfunction into an integrated clinical process, built on the foundation of a solid clinical reasoning framework. Our aim is to gain a better understanding into the inter-relationship between the restrictions of movement function and movement compensations. The breakthrough came with the realisation that some compensation strategies are normal adaptive coping mechanisms and do not demonstrate uncontrolled movement, while others are maladaptive compensation strategies that present with uncontrolled movement. This led us to develop the structured assessment process detailed in this text including the Movement Control Rating System (Chapter 3). This clinical assessment tool can identify movement control deficiencies and be valuable for reassessing improvements in motor control efficiency.

Recurrent musculoskeletal pain has a significant impact on health care costs, employment productivity and quality of life. Uncontrolled movement can be identified by observation, and corrective retraining of this uncontrolled movement may have an influence on onset and recurrence of symptoms. To date, outcome measures in terms of changes in range and strength, have not influenced the onset and recurrence of injury. The ability to assess for uncontrolled movement and to retrain movement control is an essential skill for all clinicians involved in the management of musculoskeletal pain, rehabilitation, injury prevention, and those working in health promotion, sport and occupational environments. Preventing the recurrence of musculoskeletal pain can both influence quality of life and have an economic impact.

Movement control dysfunction represents multifaceted problems in the movement system. Skills are required to analyse movement, make a clinical diagnosis of movement faults and develop and apply a patient-specific retraining program and management plan to deal with pain, disability, recurrence of pain and dysfunction. The mechanisms of aberrant movement patterns can be complex, so a sound clinical reasoning framework is essential to determine management goals and priorities. We present an assessment framework which will provide the option to consider four key criteria relevant to dysfunctional movement: the diagnosis of movement faults (site and direction of uncontrolled movement), the diagnosis of pain-sensitive tissues (patho-anatomical structure), the diagnosis of pain mechanisms and identifying relevant contextual factors (environmental and personal). This clinical reasoning framework can help identify priorities for rehabilitation, where to start retraining and how to be very specific and effective in exercise prescription to develop individual retaining programs.

Uncontrolled movement can be reliably identified in a clinical environment and related to the presence of musculoskeletal pain, to the recurrence of musculoskeletal pain and to the prediction of musculoskeletal pain. We hope this text will enable clinicians worldwide to effectively identify and retrain uncontrolled movement and help people move better, feel better and do more.

Mark Comerford
Sarah Mottram
2011

Foreword

Comerford and Mottram are to be commended for their extensive and comprehensive presentation of factors involved in movement dysfunctions. This book shares several of my own strong beliefs that have implications for the management of musculoskeletal pain conditions. Those beliefs are: 1) recognising and defining the movement system; 2) identifying and describing pain syndromes based on movement direction; 3) identifying the primary underlying movement dysfunction; 4) describing the various tissue adaptations contributing to the movement dysfunction; and 5) developing a treatment program that is comprehensive and based on the identified contributing tissue adaptations. I also share with the authors a belief that the treatment program requires the patient's active participation, which can range from control of precise, small, low force requiring movements to total body large force requiring movements. Historically – and still prevalent – is the belief that tissues become pathological as an inevitable outcome of trauma, overuse and ageing. The result is a focus on identifying the patho-anatomical structure that is painful rather than on identifying the possible contributing factors, or even how movement faults can be an inducer. We are all aware that movement is necessary to maintain the viability of tissues and bodily systems. Almost daily, studies are demonstrating the essential role of movement, in the form of exercise or activity, in achieving or maintaining health. Yet there is very little recognition that there are optimal ways of moving individual joints and limb segments as well as the total body. Similarly there is little recognition that painful conditions can be treated by correcting the movement rather than resorting to symptom-alleviating modalities, drugs or surgery. Optimal alignment when maintaining prolonged postures, such as sitting, is not considered to be necessary. I believe the situation is analogous to that of diet. For many years, no one worried about the effect on a person's health of the type or amount of food that was consumed. Indeed, more money is still spent on the alignment of the teeth than on the alignment of the body, though the function of the body is more affected by alignment faults than eating is by poor alignment of the teeth.

This book serves to reinforce and define the characteristics of the movement system and how they contribute to movement dysfunctions associated with pain syndromes. The authors have done an extensive review of the relevant literature describing the dysfunctions of the nervous and muscular systems. They have provided a detailed description of a key underlying factor, designated as uncontrolled movement, which then provides a basis for the treatment program. The detailed descriptions of the syndromes, key observations and examination forms should be most helpful in guiding the clinician. Building upon the information taken from the examination, the treatment program is also described in detail. What is particularly noteworthy is the incorporation of most of the perspectives and methods used by the best known

approaches to musculoskeletal pain. The authors have organised the rationale and methods from these varying approaches into a comprehensive approach. Comerford and Mottram have done a thorough job of describing all aspects of what could be considered the 'psychobiosocial' model of analysis and treatment of musculoskeletal pain. The timeliness of this book is reflected by the incorporation of their concepts to the International Classification of Functioning, Disability, and Health. As stated previously this book has its particular value in the comprehensiveness and detailed descriptions of possible tissue dysfunctions as reported in the literature, methods of analysis and treatment. The reader will be truly impressed by the many complexities of the movement system and the rigorous analysis that is required to understand, diagnose and treat the dysfunctions that can develop and contribute to pain syndromes. The authors have truly provided an outstanding text in its inclusive and thorough discussion of the topic of movement dysfunction.

Shirley Sahrmann, PT, PhD, FAPTA
Professor Physical Therapy, Neurology, Cell Biology and Physiology
Washington University School of Medicine – St. Louis

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Reviewers

Technical Reviewer

Prue Morgan M.App.Sc (Research), B.App.Sc (Physio)
Grad Dip Neuroscience
Specialist Neurological Physiotherapist, FACP
Lecturer, Physiotherapy
Monash University

Philippa Tindle BSc. BA. MCSP
Member of Chartered Society of Physiotherapy and
Registered with the Health Professions Council (HPC)

Contents

Section 1

Chapter 1

Uncontrolled movement

The key to managing movement dysfunction is thorough assessment. This includes the determination of any uncontrolled movement (UCM) and a comprehensive clinical reasoning process by the clinician to evaluate contributing factors which influence the development of UCM. This first chapter details the concept of UCM and the clinical reasoning process which is the framework for assessment and rehabilitation.

UNDERSTANDING MOVEMENT AND FUNCTION

Normal or ideal movement is difficult to define. There is no one correct way to move. It is normal to be able to perform any functional task in a variety of different ways, with a variety of different recruitment strategies. Optimal movement ensures that functional tasks and postural control activities are able to be performed in an efficient way and in a way that minimises and controls physiological stresses. This requires the integration of many elements of neuromuscular control including sensory feedback, central nervous system processing and motor coordination. If this can be achieved, efficient and pain-free postural control and movement function can be maintained during normal activities of daily living (ADL), occupational and leisure activities and in sporting performance throughout many years of a person's life.

The movement system comprises the coordinated interaction of the articular, the myofascial, the neural and the connective tissue systems of the body along with a variety of central nervous system, physiological and psycho-social influences (Figure 1.1). It is essential to assess and correct specific dysfunction in all components of the movement system and to assess the mechanical inter-relationships between the articular, myofascial, neural and connective tissue systems. This chapter will describe a systematic approach to evaluation of the movement system and identification of the relative contributions of individual components to movement dysfunction.

Movement faults

Identifying and classifying movement faults is fast becoming the cornerstone of contemporary rehabilitative neuromusculoskeletal practice (Comerford & Mottram 2011; Fersum et al 2010; Sahrmann 2002). In recent years clinicians and researchers have described movement faults and used many terms to describe these aberrant patterns. These terms include substitution strategies (Richardson et al 2004; Jull et al 2008), compensatory movements (Comerford & Mottram 2001a), muscle imbalance (Comerford & Mottram 2001a; Sahrmann 2002), faulty movement (Sahrmann 2002), abnormal dominance of the mobiliser synergists (Richardson et al 2004; Jull et al 2008), co-contraction rigidity (Comerford & Mottram 2001a), movement impairments

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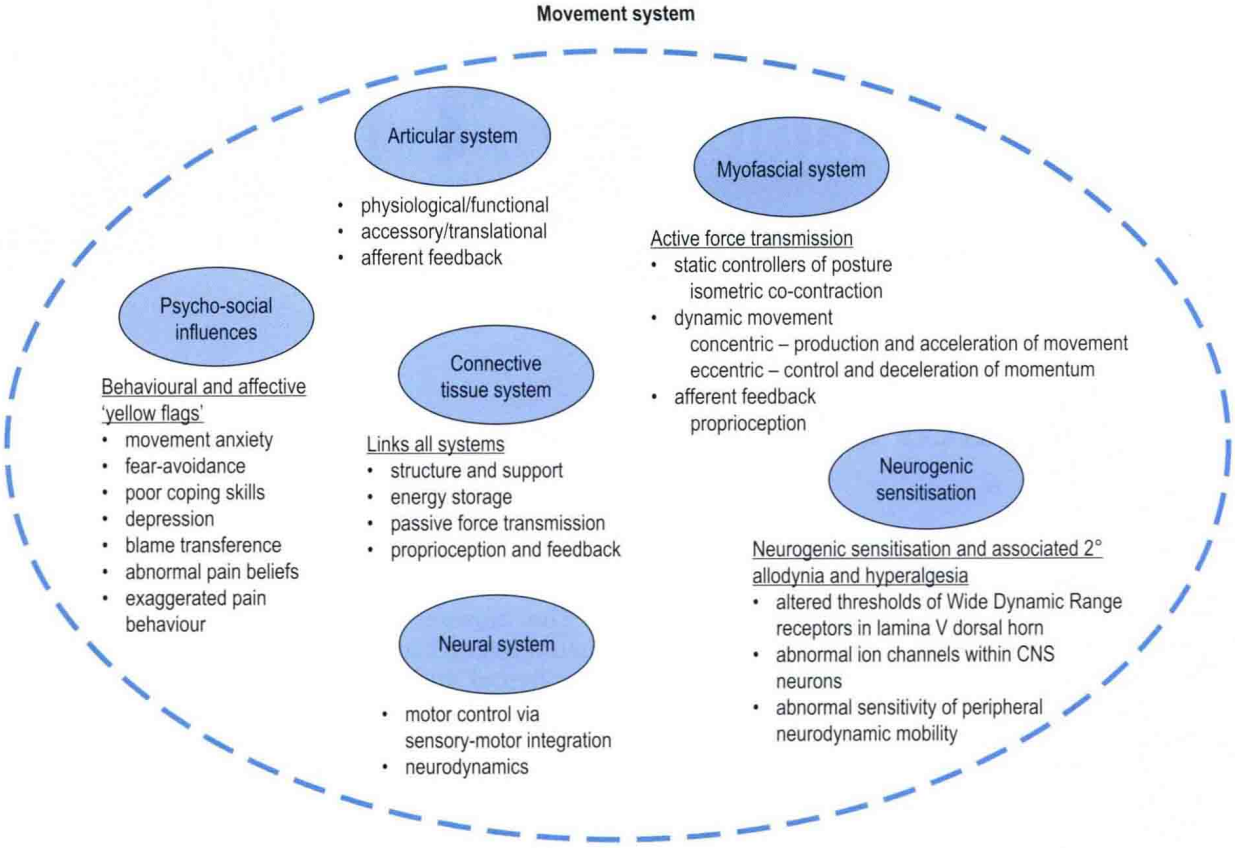

Figure 1.1 Inter-related components of the movement system

(Sahrmann 2002; O'Sullivan et al 2005) and control impairments (O'Sullivan et al 2005; Dankaerts et al 2009). All of these terms describe aspects of movement dysfunction, many of which are linked to UCM.

The focus of this text is to describe UCM and explore the relationship of UCM to dysfunction in the movement system (Comerford & Mottram 2011). Movement dysfunction represents multi-faceted problems in the movement system and the therapist needs the tools to relate UCM and faults in the movement system to symptoms, recurrence of symptoms and disability. Skills are required to analyse movement, make a clinical diagnosis of movement faults and apply a patient-specific retraining program and management plan to deal with pain, disability, recurrence of pain and dysfunction.

Sahrmann (2002) has promoted the concept that faulty movement can induce pathology, not just be the result of it; that musculoskeletal pain syndromes are seldom caused by isolated events; and that habitual movements and sustained postures play a major role in the development of movement dysfunction. These statements have been fundamental in the development of the movement dysfunction model. Clinical situations which have a major component of movement dysfunction contributing to pain include: postural pain; pain of insidious onset; static loading or holding pain; overuse pathology (low force repetitive strain or high force and/or impact repetitive strain); recurrent pain patterns; and chronic pain.

It is important to identify UCM in the functional movement system. It is our hypothesis that the uncontrolled segment is the most likely source of pathology and symptoms of mechanical origin. There is a growing body of evidence to support the relationship between UCM and symptoms (Dankaerts 2006a, 2006b; Luomajoki et al 2008; van Dillen et al 2009). The direction of UCM

relates to the direction of tissue stress or strain and pain producing movements. Therefore it is important in the assessment to identify the site and the direction of UCM and relate it to the symptoms and pathology. The UCM identifies the *site* and the *direction* of dynamic stability dysfunction and is related to the direction of symptom-producing movement. For example, UCM into lumbar flexion under a flexion load may place abnormal stress or strain on various tissues and result in lumbar flexion-related symptoms. Likewise, uncontrolled lumbar extension under extension load produces extension-related symptoms, while uncontrolled lumbar rotation or side-bend and/or side-shift under unilateral load produces unilateral symptoms.

IDENTIFICATION AND CLASSIFICATION OF UCM

Figure 1.2 illustrates the link between UCM and pain. Abnormal stress or strain that exceeds tissue tolerance can contribute to pain and pathology. The relationship between UCM and pain/pathology will be explored further in Chapter 3.

In this text the identification and classification of movement faults are described in terms of site and direction of UCM. These movement faults will be discussed in Chapter 2 in relation to changes in motor recruitment and strength (Comerford & Mottram 2001b, 2011). Scientific literature and current clinical practice are linking the site and direction of UCM in relation to symptoms, disability, dysfunction, recurrence, risk and performance (Figure 1.3).

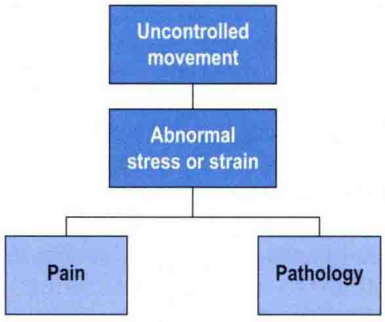

Figure 1.2 Uncontrolled movement: the link to pain and pathology

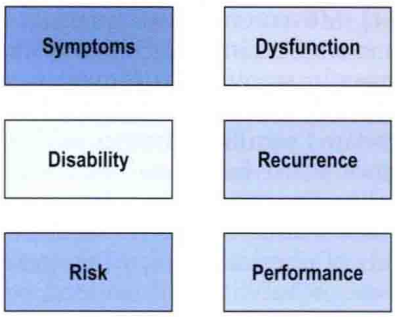

Figure 1.3 Factors relating to the site and direction of uncontrolled movement

Symptoms

Symptoms are what the patient feels and complains of and include pain, paraesthesia, numbness, heaviness, weakness, stiffness, instability, giving way, locking, tension, hot, cold, clammy, nausea and noise. The treatment of symptoms is often the patient's highest priority and is a primary short-term goal of treatment.

Pain is frequently one of the main symptoms that the patient presents with to the therapist and is inherently linked to movement dysfunction. Contemporary research clearly demonstrates that individuals with pain present with aberrant movement patterns (Dankaerts et al 2006a, 2009; Falla et al 2004; Ludewig & Cook 2000; Luomajoki et al 2008; O'Sullivan et al 1997b, 1998). Research has demonstrated a consistent finding: in the presence of pain, a change occurs in recruitment patterns and the coordination of synergistic muscles. Individuals with pain demonstrate patterns of movements that would normally be used only in the performance of high load or fatiguing tasks (e.g. pushing, pulling, lifting weights) to perform low load non-fatiguing functional tasks (e.g. postural control and non-fatiguing normal movements). Clearly UCM is a feature of many musculoskeletal pain presentations and identifying and classifying these movement faults is essential if therapists are to effectively manage symptoms by controlling movement faults.

Disability

Disability is the experienced difficulty doing activities in any domain of life (typical for one's age and sex group, e.g. job, household management, personal care, hobbies, active recreation) due to a health or physical problem (Verbrugge &

Jette 1994). Movement faults are related to disability. For example, Lin et al (2006) demonstrated that changes in scapular movement patterns (in particular a loss of posterior tilt and upward rotation) correlated significantly with self-report and performance-based functional measures indicating disability. The relationship between disability and movement faults has been identified in many other fields of physical therapy (e.g. neurological and amputee rehabilitation). Indeed, in relation to gait dysfunction, management and retraining of UCM is a key factor in rehabilitation of people with lower limb amputations using a prosthesis (Hirons et al 2007).

Reduction of disability is the primary long-term goal of therapy or rehabilitation. Disability is individual and what one person considers disability another person might consider exceptional function. For example, an elite athlete's disability may be a function that most people do not have the ability to do, do not want to do or need to do. Movement dysfunction, however, can affect a person's ability to function independently and therefore decrease quality of life. The disablement process model in disease as well as in rehabilitation is gaining recognition (Escalante & del Rincon 2002; Verbrugge & Jette 1994) and retraining movement faults has been shown to improve function (O'Sullivan et al 1997a; Stuge et al 2004).

Dysfunction

Dysfunction can imply disturbance, impairment or abnormality in the movement system. It can be objectively measured and quantified and/or compared against a normal or ideal standard or some validated or calculated benchmark. These impairments may present as weakness, stiffness, wasting, sensory–motor changes (including proprioception changes, altered coordination and aberrant patterns or sequencing of muscle recruitment) or combinations of several impairments. Dysfunction measurements include: joint range of motion (physiological or accessory); muscle strength (isometric, concentric, eccentric, isokinetic, power and endurance); muscle length; flexibility; stiffness; speed; motor control (recruitment, inhibition, coordination and skill performance); bulk (girth, volume, cross-sectional area); and alignment.

A baseline measurement of dysfunction, followed by an intervention with some form of treatment or therapy over a variable timeframe and subsequent reassessment of dysfunction provides the basis of evidence-based practice. Reduction of dysfunction is a primary short-term goal of therapeutic intervention, although the patient is frequently symptom free before dysfunction is corrected. Treatment should not cease just because the symptoms have disappeared, but may need to continue until no more dysfunctions are measurable.

The process of identifying and measuring UCM, and linking UCM to musculoskeletal pain, and to changes in muscle function, is a developing area of active research in the field of pain and movement dysfunction (Gombatto et al 2007; Luomajoki et al 2007, 2008; Mottram et al 2009; Morrissey et al 2008; Scholtes et al 2009; Roussel et al 2009a; van Dillen et al 2009). Muscle dysfunction is most clearly apparent in people with pain (Falla & Farina 2008; Hodges & Richardson 1996; Hungerford et al 2003; Lin et al 2005). The changes in muscle function underlying pain can present in two ways: 1) as altered control strategies (van Dillen et al 2009; O'Sullivan 2000); and 2) as physiological peripheral muscle changes (Falla & Farina 2008). Physiological changes associated with muscle dysfunction are discussed further in Chapter 2, and altered control strategies are discussed further in Chapter 3.

Recurrence

The correction or rehabilitation of dysfunction has been shown to decrease the incidence of pain recurrence (Hides et al 1996; Jull et al 2002; O'Sullivan et al 1997a). This reinforces the need for therapy to be aimed at correcting dysfunction in the management of musculoskeletal disorders and not just relieving symptoms.

Risk of injury

Evidence suggests history of injury is a predictive factor for re-injury and therefore outcome measures that are defined in terms of normal range of joint motion and muscle strength are inadequate to prevent recurrence (Mottram & Comerford 2008). Making the link between UCM and pain is not new, but the concept of linking it to injury prevention is.

Some recent research has highlighted the potential for linking UCM to risk of injury. A recent study on dancers identified two movement

control tests that may be useful for the identification of dancers at risk of developing musculoskeletal injuries in the lower extremities (Roussel et al 2009a). Athletes with decreased neuromusculoskeletal control of the body's core (core stability) are at an increased risk of knee injury (Zazulak et al 2007). Indeed, there is now growing evidence that motor control and physical fitness training prevent musculoskeletal injuries (Roussel et al 2009b), highlighting the importance for therapists to be more knowledgeable about movement control and function.

Performance

At present there is little published literature to relate UCM to performance. However, anecdotal empirical evidence has shown that retraining movement faults can improve performance in athletes.

The movement dysfunctions associated with pain and disability have been shown to be reversible so there is a developing need to identify UCM in relation to injury risk and performance and to objectively evaluate the outcome of retraining.

A MODEL FOR THE ASSESSMENT AND RETRAINING OF MOVEMENT FAULTS

Many clinicians and researchers have made a significant contribution to the body of evidence relating to movement, movement impairments and corrective retraining. Some have described a particular approach to assessment and retraining and most support each other's philosophies or provide different pieces of the puzzle to enable an understanding of the 'whole picture'. No single approach has all the answers but the therapist who wants to provide 'best practice' for clients can benefit enormously from a synthesis of the different approaches and concepts proposed to date, along with the ongoing development and integration of original ideas and applied principles.

Figure 1.4 illustrates the development of the *movement analysis model*. The movement analysis model identifies UCM in terms of the site (joint), direction (plane of motion) and recruitment threshold (low or high) and further establishes links to pain, disability, dysfunction, recurrence, risk of injury and performance. This model has been developed through the analysis and synthesis of historical and contemporary research from many sources; however, it is not intended to be a comprehensive summary of the current level of knowledge surrounding movement analysis.

Kendall and colleagues (2005) described muscle function in detail. Their now classic text has been the foundation for assessment of muscle function, especially with reference to the graded testing of muscle strength and analysing the interrelationship of strength and function. Janda (1986) had previously developed the concept of muscle imbalance and patterns of dysfunction by analysing the pattern of movement sequencing. His primary intervention was to increase extensibility of short muscles. Sahrmann (2002) and co-workers further developed the concept of muscle imbalance, again analysing patterns of movement, and have developed a diagnostic framework for movement impairments (direction susceptible to motion).

The 1990s saw a huge advancement in the identification of motor control dysfunction (Jull et al 2008; Richardson et al 2004). Hodges (Hodges & Cholewicki 2007) has developed a large body of evidence linking motor control of deep muscles to spinal stability. O'Sullivan and co-workers have provided objective measurements to support the links between altered muscle recruitment and direction-related musculoskeletal pain (Dankaerts et al 2006a). From this research a classification system based on diagnostic subgroups has been proposed (Vibe Fersum et al 2009).

Vleeming et al (2007) and Lee (2004) have developed the model of form and force closure and have linked this to anatomical fascial slings. McGill's (2002) research has emphasised the importance of training more superficial muscles to stabilise the core during loaded and sporting function and is often referred to as core strengthening. All these clinicians and researchers have contributed important aspects to a comprehensive and integrated model of movement analysis.

Alternative therapies

In the search to identify the defining characteristics of therapeutic exercise, a brief review and analysis of many different approaches and concepts including alternative therapies is appropriate. Some of these approaches are supported by

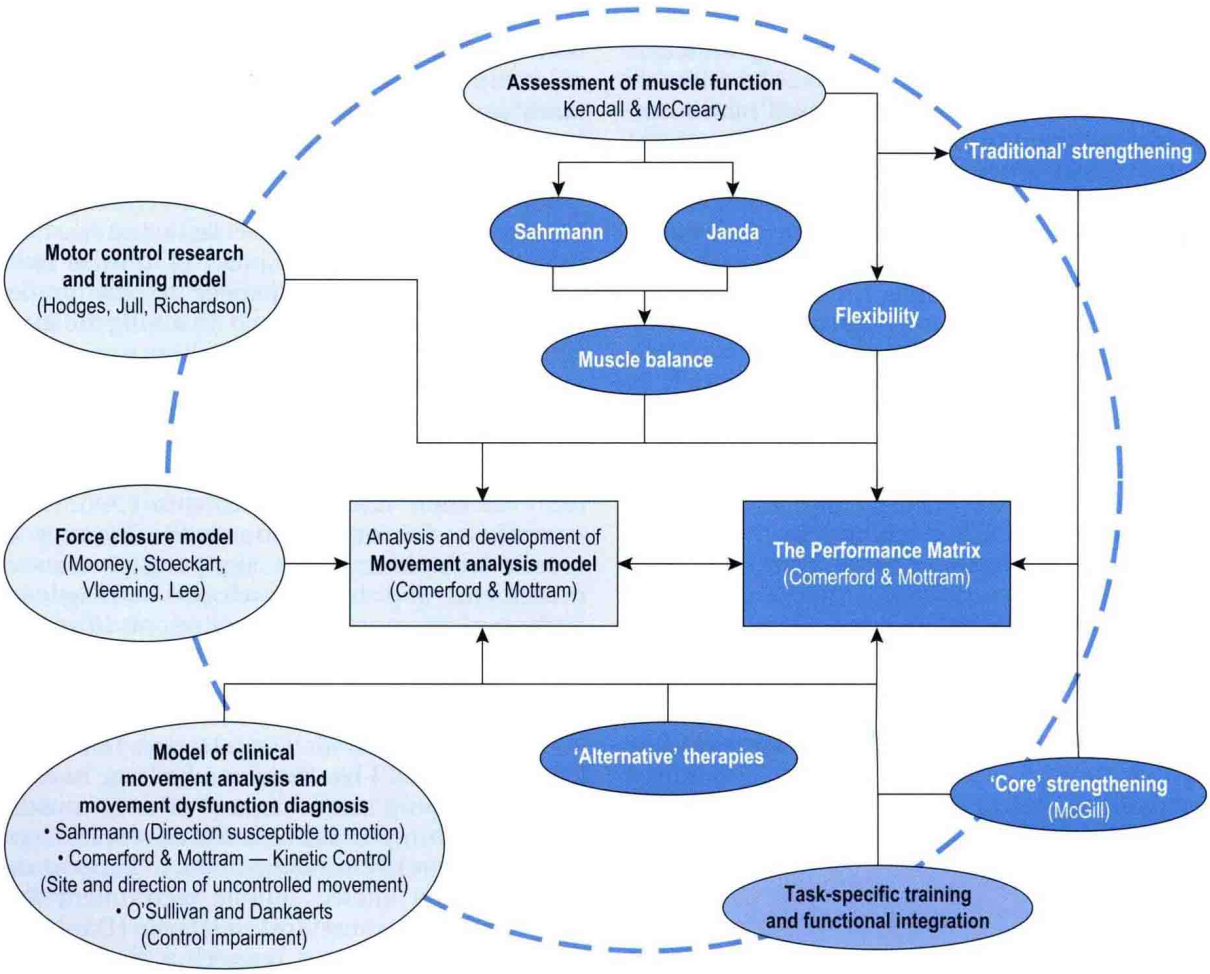

Figure 1.4 The development of the movement analysis model

clinical evidence (Emery et al 2010; Rydeard et al 2006). Box 1.1 lists some useful approaches to pain management and/or movement dysfunction to explore. Many exercise approaches have either stood the test of time or their popularity suggests that people who practise them feel or function better.

Whilst the various exercise concepts feature distinctive elements that characterise their approach, there are features that are common to all approaches (Box 1.2). These common features may contribute to good function and warrant closer inspection and further investigation. Breathing control is a key feature in many of these therapies. The link between respiratory disorders

Box 1.1 **Useful alternative therapies in the management of movement dysfunction**

Tai chi
The Alexander technique
Yoga
Pilates
Physio ball (Swiss ball)
Feldenkrais
Martial arts
GYROTONIC®