Spinal Stabilisation
1. Active Lumbar Stabilisation – Concepts

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Key Words

Exercise, fitness components, low back pain, spinal stabilisation.

Summary

This introductory paper is the first of a series of five articles on active lumbar stabilisation. The common occurrence of low back pain and the importance of exercise in the management of this condition is discussed. It is suggested that exercise therapy is a vital skill for physiotherapists, but one which is often seen as secondary to electrotherapy and manual therapy. The importance of remaining at the forefront of modern developments in exercise therapy is emphasised. The concept of three interrelating systems for active lumbar stabilisation is described, and the physical signs of instability examined. A programme to enhance active lumbar stabilisation is introduced. The necessity of balancing the fitness components enhanced during rehabilitation is emphasised with reference to the functional requirement of the patient.

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Acknowledgments

I acknowledge the assistance of the following individuals and institutions in the preparation of this series: Claire Erskine, Merry Lester, Institute of Graduate Physical Therapy; the medical illustration department, Withington Hospital; and the office of Shirley Sahrmann, Washington University.

The Cost of Low Back Pain

It is estimated that 80% of the population will suffer at least one disabling episode of low back pain during their lives, and at any one time as many as 35% of people will be suffering from backache of some sort (Fryomoyer and Cats-Baril, 1991). This translates into a tremendous cost in terms of personal suffering and a equally large financial burden to the country. About 46.5 million working days were lost through back pain in 1989 representing a cost to the National Health Service of £156 million per year, and an even larger cost to industry of £1,018 million each year (Tye and Brown, 1990).

The Importance of Exercise in Low Back Pain Management

Rest is the most common treatment for back pain despite the fact that prolonged bed rest has been shown to be harmful. Controlled exercises restore function, reduce distress, illness behaviour and pain, and promote a return to work (Waddell, 1987). Rest has little effect on the natural history of back pain, and may actually increase the severity of pain (Twomey and Taylor, 1994). In proposing a new model for the treatment of low back pain Waddell (1987) recommended that the role of the patient should change from a negative philosophy of rest and simply being a passive recipient of treatment, to a more positive active role of sharing the responsibility for the restoration of function.

Physiotherapy and Exercise

Although manual therapy and electrotherapy are used widely by physiotherapists, the standard and frequency of use of exercise therapy in general have been criticised (Lamb and Frost, 1993). An underlying theme of this series of articles is that exercise therapy is a specialist clinical skill. As such it is a key tool to the restoration of patients' well-being. Indeed, the study of movement dysfunction (pathokinesiology) in its broader sense has been described as the distinguishing clinical science of physical therapy (Hislop, 1975). If this is so, then perhaps exercise therapy should be described as the distinguishing clinical skill of physiotherapy. For it is often exercise therapy, more than any other clinical skill, which sets the physiotherapy profession apart from others involved in the management of musculoskeletal dysfunction.

It has been claimed that physiotherapy, in line with other professions, has an inherent responsibility to integrate knowledge from related research into clinical practice (Winstein and Knecht, 1990). In the case of exercise therapy, physiotherapists can greatly enhance their clinical skills by drawing on aspects of sport and movement science – especially biomechanics, exercise physiology, and sports psychology. Inevitably, the patients will be the ultimate beneficiaries of this improvement in exercise expertise.

This article series attempts to review work from the movement science field and incorporate it into the practice of clinical exercise therapy.

The Concept of Lumbar Stabilisation

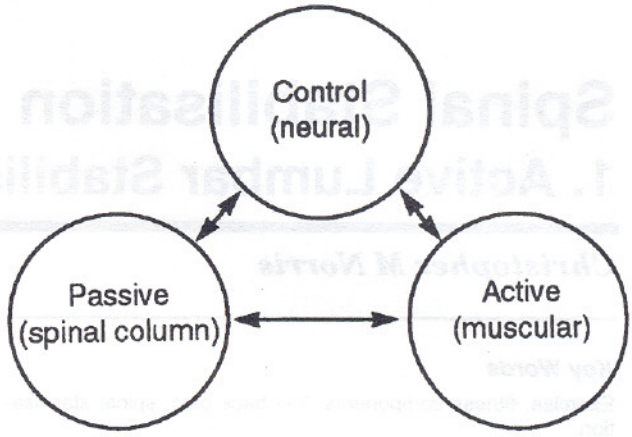
Lack of stability (instability) of the lumbar spine must be contrasted with hypermobility. In both conditions the range of motion is greater than normal. However, instability is present when there is 'an excessive range of abnormal movement for which there is no protective muscular control'. With hypermobility, stability is provided because the 'excessive range of movement ...has complete muscular control' (Maitland, 1986). The essential feature of stability is therefore the ability of the body to control the whole range of motion of a joint, in this case the lumbar spine.

When the lumbar spine demonstrates instability, there is a failure to maintain correct vertebral alignment. The unstable segment shows decreased stiffness (resistance to bending) and as a consequence movement is increased even under minor loads. Both the quality and quantity of motion are therefore altered. Clinically, with reference to the lumbar spine, this description of instability means that there is no damage to the spinal cord or nerve roots, and no incapacitating deformity. However, because movement is excessive, pain sensitive structures may be either stretched or compressed and inflammation may occur (Kirkaldy-Willis, 1990; Panjabi, 1992). Clinical assessment may reveal a number of physical signs suggesting instability as outlined in table 1.

Table 1: Physical signs of instability
(Paris, 1985; Maitland, 1986)

Step deformity (spondylolisthesis) or rotation deformity (spondylolisis) on standing which reduces on lying
Transverse band of muscle spasm which reduces on lying
Localised muscle twitching while shifting weight from one leg to the other
Juddering or shaking during forward bending
Alteration to passive intervertebral motion testing, suggesting excessive mobility in the sagittal plane

To maintain spinal stability, three interrelated systems have been proposed (see figure). Passive support is provided by inert tissues, while active support is from the contractile tissues. Sensory feedback from both systems provides co-ordination *via* the neural control centres (Panjabi, 1992). Importantly, where the stability provided by one system reduces, the other systems may compensate. Thus the proportion of load taken by the active system may increase in order to minimise stress on the passive system through



The spinal stabilising system consists of three interrelating sub-systems (Panjabi, 1992)

load sharing (Tropp *et al,* 1993). This gives the physiotherapist the opportunity to reduce pain and improve function by rehabilitating active lumbar stabilisation. Such improvement may be accomplished by augmenting both the active and neural control systems. Simply developing muscle strength is insufficient. Moreover, many popular strength exercises for the trunk actually increase mobility in this region to dangerously high levels (Norris, 1993, 1994a). Rather than improving stability, exercises of this type may reduce it and could therefore increase symptoms, especially those associated with inflammation.

Fitness Components and Rehabilitation

A working model of physical fitness in relation to rehabilitation may be seen as a number of interrelating 'S' factors (table 2). To be effective,

Table 2: 'S' factors of fitness

Factor	*Concept*
Stamina	Cardiopulmonary and local muscle endurance
Suppleness	Passive and active flexibility
Strength	Isometric, isotonic (concentric and eccentric), isokinetic strength
Speed	Speed (rate of movement) and power (rate of doing work)
Skill	Motor skill
Specificity	Overload must match tissue adaptation required
Spirit	Psychological aspects of injury, especially illness behaviour

a rehabilitation programme must cover all fitness components which are relevant to the performance of a particular task. A programme which fails to do this will lead to imbalance. For example, we have seen that excessive suppleness (flexibility) in relation to strength may lead

to instability of a joint. Similarly, increased strength without a parallel improvement of muscle reaction speed has been shown to leave a patient unable to make use of his/her extra strength in functional situations (Konradsen and Ravn, 1990). Increases in either strength or flexibility which fail to improve skill may make injury more likely (Tropp *et al,* 1993). The need for exercises to be specific to the tasks a subject must perform has been demonstrated during exercise therapy (Hemborg *et al,* 1985). The need to consider psychological factors such as illness behaviour in back injury, and the way that exercise therapy may affect these factors has been shown to be vital (Main, 1992).

Developing Active Lumbar Stability

Poor postural control places excessive stress on the body tissues and can leave the spine vulnerable to injury (Kendall *et al,* 1993). One important aspect of posture with reference to the lumbar spine is the ability of the trunk muscles to protect the spinal tissues from excessive motion. To do this, the muscles surrounding the trunk must be able to co-contract isometrically in functional situations (Richardson *et al,* 1990). The synergistic interaction between the various trunk muscles in this situation is complex. Some muscles act as prime movers to create the gross movements of the trunk, while others function as stabilisers (fixators) and neutralisers to support the spinal structures and control unwanted movements. Rehabilitation of active lumbar stabilisation is concerned not just with the torque producing capacity of muscles, but with a subject's ability to co-ordinate automatically an optimal pattern of muscle activity (Jull and Richardson, 1994).

Structure of Article Series

This series of articles looks at one type of exercise for the management of low back pain. The aim of the exercise programme is to enhance the active stabilising mechanisms of the lumbar region, and in so doing enhance the restoration of function to this body area and to the patient as a whole. Further, by enhancing active stabilisation the exercise programme has an important role in preventive health care, an expanding area for physiotherapists (Norris, 1994b).

The programme aims to exercise the spine in mid-range initially and to teach patients to recognise when the spine is moving away from this position in both exercise and daily living situations. The biomechanics of the lumbar spine is therefore considered in part 2 with reference to the lumbar tissues placed at risk when end range motion is reached. The stabilisation programme seeks to enhance active stabilisation of the lumbar spine rather than simply to increase the strength of the trunk musculature. Quality of movement (in terms of skill) rather than pure strength is the essential factor. Part 3 of this series therefore addresses the stabilising mechanisms of the lumbar spine. Balance between muscle action (especially strength, suppleness, and the order of muscle contraction) is essential for the correct functioning of the body (White and Sahrmann, 1994) and for this reason part 4 of this series addresses the topic of muscle imbalance and the lumbar spine.

Part 5 of this series offers an exercise programme to develop progressively the active stabilising system of the lumbar spine. This addresses the development of endurance capacity (stamina) within postural muscles responsible for stabilising the area and the restoration of correct movement patterns (skill) needed to carry out activities of daily living with minimal stress to the lumbar tissues. The emphasis of this programme is on the restoration of function rather than the development of isolated fitness components or the elimination of pain. In the final stages of the exercise programme we aim to make the muscle contraction responsible for active stabilisation into an automatic response. At this stage we must work for speed of muscle contraction specific to the functional tasks that patients must carry out in their activities of daily living.

References

Fryomoyer, J W and Cats-Baril, W L (1991). 'An overview of the incidences and costs of low back pain', *Orthopedic Clinics of North America,* **22**, 263.

Hemborg, B, Moritz, U, Hamberg, J, Holmstrom, E, Lowing, H and Akesson, I (1985). 'Intra-abdominal pressure and trunk muscle activity during lifting. (III) Effects of abdominal muscle training in chronic low-back patients', *Scandinavian Journal of Rehabilitation Medicine,* **17**, 15–24.

Hislop, H J (1975). Tenth Mary McMillan lecture: 'The not-so-impossible dream', *Physical Therapy,* **55**, 1069–80.

Jull, G A and Richardson, C A (1994). 'Rehabilitation of active stabilization of the lumbar spine', in: Twomey, L T and Taylor, L T (eds) *Physical Therapy of the Low Back,* 2nd edn, Churchill Livingstone, Edinburgh.

Kendall, F P, McCreary, E K and Provance, P G (1993). *Muscles, Testing and Function,* 4th edn, Williams and Wilkins, Baltimore.

Kirkaldy-Willis, W H (1990). *The Lumbar Spine,* W B Saunders, Philadelphia.

Konradsen, L and Ravn, J B (1990). 'Ankle instability caused by prolonged peroneal reaction time', *ACTA Orthopaedica Scandinavica,* **61**, 5, 388–390.

Lamb, S and Frost, H (1993). 'Exercise – The other root of our profession', *Physiotherapy,* **79**, 11, 772.

Main, C J (1992). 'Psychological approaches to management and treatment' in: Jayson, M I V (ed) *The Lumbar Spine and Back Pain,* 4th edn, Churchill Livingstone, Edinburgh.

Maitland, G D (1986). *Vertebral Manipulation,* 5th edn, Butterworth, London.

Norris, C M (1993). 'Abdominal muscle training in sport', *British Journal of Sports Medicine,* **27**, 1, 19–27.

Norris, C M (1994a). 'Abdominal training. Dangers and exercise modifications', *Physiotherapy in Sport,* **19**, 5, 10–14.

Norris, C M (1994b). 'Fitness and health programmes' in: Richardson, B and Eastlake, A (eds) *Physiotherapy in Occupational Health,* Butterworth Heinemann, Oxford.

Panjabi, M M (1992). 'The stabilising system of the spine. Part 1. Function, dysfunction, adaptation, and enhancement', *Journal of Spinal Disorders,* **5**, 4, 383–389.

Paris, S V (1985). 'Physical signs of instability', *Spine,* **10**, 3, 277–279.

Richardson, C, Toppenberg, R and Jull, G (1990). 'An initial evaluation of eight abdominal exercises for their ability to provide stabilisation for the lumbar spine', *Australian Journal of Physiotherapy,* **36**, 6–11.

Tropp, H, Alaranta, H and Renstrom, P A F H (1993). 'Proprioception and co-ordination training in injury prevention' in: Renstrom, P A F H (ed) *Sports Injuries: Basic principles of prevention and care,* IOC Medical Commission publication, Blackwell, London.

Twomey, L T and Taylor, L T (1994). 'Intensive physical rehabilitation for back pain' in: Twomey, L T and Taylor, L T (eds) *Physical Therapy of the Low Back,* 2nd edn, Churchill Livingstone, Edinburgh.

Tye, J and Brown, V (1990). *Back Pain – The ignored epidemic,* British Safety Council, London.

Waddell, G (1987). 'A new clinical model for the treatment of low-back pain', *Spine,* **12**, 7, 632–644.

White, S G and Sahrmann, S A (1994). 'A movement system balance approach to management of musculoskeletal pain' in: Grant, R (ed) *Physical Therapy of the Cervical and Thoracic Spine,* 2nd edn, Churchill Livingstone, Edinburgh.

Winstein, C J and Knecht, H G (1990). 'Movement science and its relevance to physical therapy', *Physical Therapy,* **70**, 759–762.