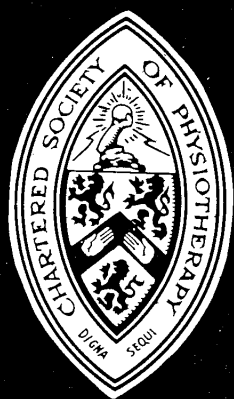


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The Concept of Adverse Mechanical Tension in the Nervous System

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The Concept of Adverse Mechanical Tension in the Nervous System

Part 1: Testing for 'Dural tension'

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Summary: The concept of using tests such as the straight leg raise and prone knee bend to stress 'dura' or what Maitland (1978) has termed 'pain sensitive structures within the vertebral canal' is believed to be an oversimplification of the true anatomical and biomechanical facts. This paper expands this concept to embrace the nervous system as a whole. It introduces the term 'adverse mechanical tension of the nervous system' to explain how pathology affects the normal movement and biomechanics of the nervous system and its surrounding tissues. Mechanisms of sign and symptom production based on current literature are also put forward.

The standard or 'base' tension tests and relevant biomechanics are reviewed and some new variations/combinations described. The key feature of this approach is to understand basic principles of tension testing and to be able to apply them to a wide variety of clinical presentations.

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Louis Gifford trained at Sheffield City Polytechnic where his interest in manipulative therapy was first fostered. After working in Walton Hospital, Liverpool, and St Stephen's Hospital, Chelsea, he went on to complete the one-year postgraduate Diploma in Advanced Manipulative Therapy in Adelaide, South Australia, in 1985. He then spent two years working and teaching in Adelaide before returning in 1988 to private practice in Falmouth. His interest in manual treatment of mechanical disorders of the nervous system has been the result of a close friendship and working relationship with Mr David Butler.

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Figure 9 is adapted from 'The upper limb tension test by Kenneally *et al* in *Physical Therapy of the Cervical and Thoracic Spines*, edited by R Grant, published by Churchill Livingstone, 1988.

IN recent years manipulative therapy has broadened its horizons and taken in a concern for what Maitland (1978) has called 'movement of pain sensitive structures within the vertebral canal' — notably the 'neuromeningeal tissues'. Many therapists are laudably attending to abnormalities in neural tissue tension/mechanics as well as mobilising joints and muscles in the quest for more consistent results. So-called 'tension tests' are not new; what is new is the refining of the old standard tests — straight leg raise (SLR), prone knee bend (PKB), passive neck flexion (PNF), the combination of some of these tests (slump) and the development of a test that stresses neural tissue in the upper

limb — the upper limb tension test (ULTT) (Elvey, 1979). These tests have superseded their original purpose of being of purely diagnostic importance and are now fully integrated into passive mobilising treatment techniques (Maitland, 1985; Elvey, 1986; Butler, 1987; Kenneally *et al*, 1988).

Rather than limit our thinking about these tests as stressing 'dura' they should now be considered in the far broader context of the nervous system as a whole. A SLR moves and tensions all components of the sciatic nerve from its terminations in the foot to its origins in the spinal canal and beyond. Structures that must be considered include:

- The nerve as a whole and its surrounding tissues (muscle, bone, fibrous tissue, etc).
- The connective tissue components within the nerve (epineurium, perineurium and endoneurium) which have their own intrinsic nerve supply (Hromada, 1963) and are therefore capable of producing symptoms.
- The connective tissues within the spinal canal — namely the meninges (dura, arachnoid, pia) plus intra-'cord' connective tissues.
- The conducting elements of the nervous system (the neurones).
- The intrinsic blood supply of the nervous system.

It is important to emphasise the close mechanical relationship between nerves on one side of the body or in a single limb to other nerves in the same limb or other limbs and also to the autonomic trunks and ganglia. Changes of tension in lumbar nerve roots have been clearly demonstrated during PNF (Brieg and Marions, 1963; Tencer *et al*, 1985), and instant alteration in neck and arm pain by the addition of ankle dorsiflexion to a SLR is a frequent clinical occurrence, as is the alteration in the intensity of headaches with a similar manoeuvre.

Thinking of the nervous system as an organ stresses its continuity and emphasises that any interference with part of the system may have implications for the whole. While it is primarily considered in an impulse-conducting role, it also has to be capable of adapting to body movement and in positions such as the slump test it can easily be shown to limit the ranges of movement of the test (see section on the slump test). Without interference to impulse conduction, the nervous system adapts to endless combinations, ranges and speeds of movement of the body. For instance, it has to cater for a spinal canal that is up to 9 cm longer in flexion than extension (Louis, 1981) and peripheral nerves that are located on the opposite side of joint axes such as the femoral and sciatic nerves at the hip.

In order to avoid confusion, Butler (1987) has introduced the term 'adverse mechanical tension in the nervous system' (AMT) after Brieg (1978) rather than using 'neural tension' which implies that conducting elements of the nervous system are abnormal; or 'dural tension' which limits our thoughts to the spinal canal.

'Tension tests', and for that matter body movements, not only produce an increase in *tension* within the nerve but also

move the nerve in relation to its surrounding tissues. These surrounding tissues have been referred to as 'mechanical interface' tissues (Butler, 1987). The mechanical interface (MI) should be regarded as the tissue most anatomically adjacent to the nervous system that can move independently of the nervous system, for example, the supinator muscle is a MI to the radial nerve as it passes through the radial tunnel.

Thus pathology at the MI anywhere along the length of a nerve can give rise to abnormalities in nerve movement and cause increases in tension within the nerve that may have far-reaching effects. A common example of MI pathology is lumbar disc protrusion or osteophyte impingement on a nerve root in an intervertebral foramen.

However, there are many vulnerable sites in the body where lesions that affect the elasticity and movement of the nervous system are known to begin (Sunderland, 1978; Dawson *et al*, 1983). Soft tissue or fibro-osseous tunnels such as the carpal tunnel are frequently encountered sites where MI pathology begins. This 'pathology' can be thought of in a purely mechanical sense termed 'pathomechanics' or in an 'inflammatory' or 'chemical' sense termed 'pathophysiology' (Elvey, 1987). Sunderland (1976) has established how inflammatory changes occurring around a nerve can lead to changes in the connective tissues within nerves leading to 'intra-neural fibrosis' with consequent alterations in conduction. Fibrotic nerves lose elasticity and may therefore influence the tested extensibility exhibited when performing standard 'tension tests'. Pathophysiological changes can therefore lead to pathomechanics.

Butler (1987, 1989) has attempted to categorise movement disorders of the nervous system into those which affect the movement and tension of nerves from outside the nerve, termed 'extraneural', and those which affect it from within the nerve, termed 'intra-neural'. The two can obviously occur together. As discussed above, extraneural pathology can lead to intra-neural pathology such as fibrosis and it seems reasonable to assume that primary changes within the nerve (intra-neural) could bring about a sequence of pathological events operating in the opposite direction resulting in extraneural pathology. Sunderland (1976) refers to fibrosed nerve setting up a 'friction fibrosis elsewhere'.

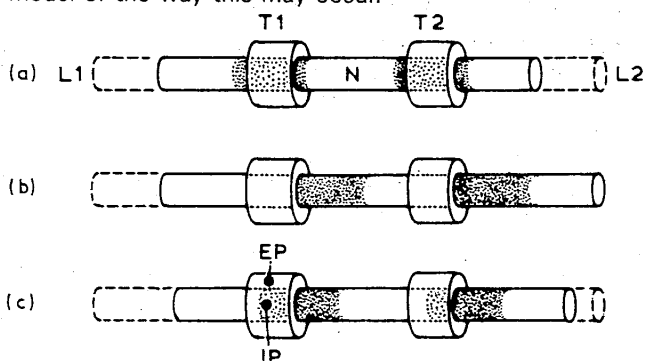
From clinical observation of patients with positive tension tests yet negative electrodiagnostic tests it appears that intra-neural pathology of the connective tissues may occur without measurable detriment to the conducting elements. Even if nerve fibres are injured, and responsible for symptoms, an uninjured funiculus may still account for the normal electrodiagnostic test (MacKinnon and Dellon, 1986).

It should be clear that a positive 'tension test' is not an emphatic indicator of a spinal disorder, it is — more vaguely — an indicator of adverse mechanical tension somewhere in the nervous system. It is up to the skilled therapist to isolate the sources or site of the AMT.

A mechanism whereby a primary and often long-standing disorder, perhaps originating in the spine, can give rise to secondary and 'remote' disorders in the periphery (or the reverse) has been postulated (Butler, 1987, 1989). Reference to the 'double crush' phenomenon supports the theory which neatly fits some commonly found clinical situations where symptoms 'spread' or 'jump' to different areas over the course of time. The double crush phenomenon is a term introduced by Upton and McComas (1973). These authors examined 115 patients with either carpal tunnel syndrome or lesions of the ulnar nerve at the elbow and found that 81 (70%) had electrophysiological and clinical evidence of

neural lesions at the neck. Dyro (1983) noted and found it hard to explain why 27% of a group of 50 young people he examined with brachial plexus lesions developed carpal tunnel syndrome. Crymble (1968) noted a similar occurrence. Lundborg (1988) has referred to a 'reversed double crush' referring to patients who present with an ulnar nerve entrapment at the wrist who then go on to develop ulnar nerve entrapment at the elbow. Another example, stressing nerve interaction in one limb, is the higher incidence of lateral epicondylitis in patients with carpal tunnel syndrome (Murray-Leslie and Wright, 1976).

Upton and McComas (1973) believe altered 'axoplasmic flow' to be the underlying cause of the observed phenomenon. However, prolonged AMT in one area of a nerve (or within the spinal canal) is bound to have mechanical repercussions further along the tract. Sunderland (personal communication, 1988) considers such an explanation feasible. Figure 1 diagrammatically illustrates a theoretical model of the way this may occur.



T1, T2 = tunnel sites N = nerve

L1, L2 = position that N can reach during normal movement with T1 and T2 constant

The stippled area represents the surface of N that can be in contact with T1 or T2 during normal movement

- (a) Neutral
- (b) To reach L2, N has moved in relation to T1 and T2 and increased intra N tension
- (c) With extraneural pathology (EP) and/or intra-neural pathology (IP) at T1, for N to reach L2 requires increased intra N tension and increased friction as the stippled area can now never be free of T2 during movement

Fig 1: Possible effect of extraneural and intra-neural pathology at one site on other sites along the nerve trunk

Basic Principles of Tension Testing

Tension tests affect a lot of other structures as well as moving and tensioning nerves. Normal neural tissue which is being moved by testing may come into contact with sensitive interface structures and elicit pain. Although in this situation the tension test can be 'proved' by adding distal or proximal sensitising manoeuvres, the culpable tissue may still be extraneural in origin. An example may be a zygapophyseal joint in the lumbar spine. Here, a SLR may bring the adjacent nerve root into contact with the anterior aspect of the joint and adding dorsiflexion would increase pressure and consequently exacerbate symptoms. Often, treating one or other of the tissues is the only way to draw a retrospective diagnostic conclusion.

When performing a tension test the operator must:

1. Be aware of expected normal responses.
2. Know all details of all the symptoms.
3. Know the symptoms in the starting position.

4. Carefully monitor symptoms throughout the procedure and be able to make the patient clear about the *symptoms complained of* as compared to any pain or discomfort caused by the test. The patient has to be made to concentrate.

Reproduction of the patient's symptoms during testing is very useful and can be conclusive but so often many tissues are moved and stressed by a single manoeuvre. A unique aspect of tension testing is that symptoms can be changed by the addition of remote testing procedures known as 'sensitising additions'. The addition of ankle dorsiflexion to a SLR causing an increase in lumbar symptoms is an example. In order to be conclusive, the emphasis must be on precise handling and communication with the patient. The slightest movement of the patient's leg/back/head/trunk while a SLR is held and while the operator fumbles to add dorsiflexion to the test is bad handling and gives misleading results. All tension tests have sensitising additions which are used to add weight to and confirm a 'diagnosis' of AMT. These are dealt with under each test.

5. Also to be noted during testing are:

- The range of movement; where pain starts (P1) and if non-irritable, a predetermined acceptable pain limit (P2) (Maitland, 1986).
- The type/area of pain and other symptoms.
- The end feel (ie R1-R2 curve) (Maitland, 1986).
- The effect of sensitising additions/subtractions on the symptoms produced.

Always compare with the contralateral limb if possible and/or with what is known to be normal (see individual tests).

Positive Tension Tests — Guide lines

A tension test is deemed positive if the patient's symptoms are reproduced by the procedure *and* if they then can be changed by adding or subtracting sensitising manoeuvres.

Frequently the exact symptoms complained of cannot be produced, but the test may still be seen as relevant and positive if the symptoms produced are different from what is known to be normal or different from the response of the opposite limb.

The range of movement achieved is often a strong guide to test relevance. Altering sensitising additions can cause changes in the range of test movements. Small differences in range of movement when compared to non-symptomatic contralateral limbs can be relevant, for example in disorders when symptoms are manifest only after extreme and lengthy activity. Restoring normal range by treatment may be the only way of clarifying the relevance of minor asymmetrical range discrepancies.

As pointed out earlier, a positive tension test does not necessarily indicate that there is a mechanical disorder of the nervous system. The tension tests may be placing a force on a surrounding interface structure. Another consideration is that part of the nervous system may be irritated and symptom-provocative, but the mechanics are normal. Irritation of nerves rather than compression has been suggested as a potent and underestimated symptom producer (Triano and Luttges, 1982). Elvey (1986, 1987) makes the suggestion that nervous system mobilisation may have a beneficial physiological effect by causing pressure changes within the system.

A positive tension test gives the therapist a valid reason to examine away from the symptom area and known referral sources. For example, with a slump test including knee extension positive for headache, the entire spine may need

examination. Sources of altered nervous system movement and tension may be a considerable distance from the area of symptoms. Butler (1987, 1989) advocates that areas where the nervous system moves little relative to its surrounding interface during movement or where the system is relatively fixed are likely focal points of AMT and should be strongly considered in the objective examination. These areas have been termed 'tension points' (Butler, 1987) and are dealt with during discussion of the tests.

Nervous system mechanics cannot be adequately examined by one traditional tension test. For example, it is not enough to examine the SLR, find it negative and declare that AMT has no part in the patient's symptoms. Differing spinal, hip, knee and ankle positions may be required. Subjective clues and a knowledge of nerve biomechanics must be used to make up new tension tests in order to fit the test to the patient's complaint. It should be regarded as a concept of testing, not just a series of 'base tests'. Just as present-day manual therapy encourages the examination of a joint in many directions (Maitland, 1986) this also applies to the nervous system. It is the aim of these two articles to promote the exploration of tension testing combinations often unique to individual patients.

The Base Tests

The Straight Leg Raise

It is well known that on performing a SLR that there is considerable caudad movement of lumbosacral nerve roots in relation to interfacing tissue such as the intervertebral foramen (Goddard and Reid, 1965; Breig, 1978), yet little consideration has been given to the rest of the sciatic tract. Smith (1956) has shown that the tibial nerve proximal to the knee also moves caudad in relation to its mechanical interface. Distal to the knee, the tibial nerve moves cranially in relation to its mechanical interface (fig 2). Thus there is a point posterior to the knee where the nerve/mechanical interface relationship is constant during SLR, an area referred to as a 'tension point'. The common peroneal nerve is quite firmly attached at the head of the fibula, making this its tension point.

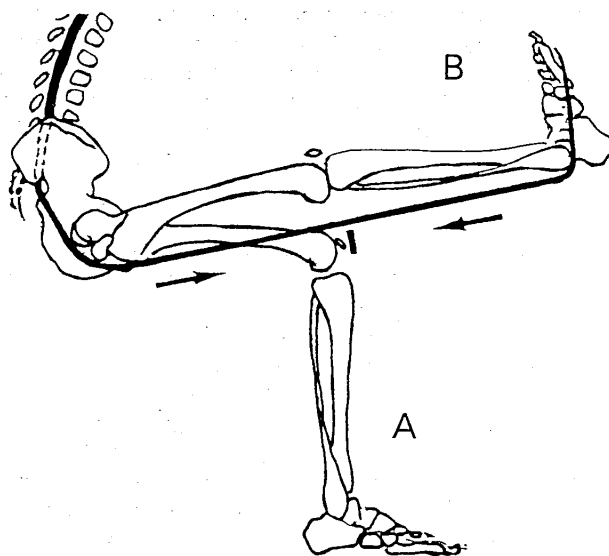


Fig 2: From position A to position B, movement of the tibial nerve in relation to the tibia and femur is in the direction of the arrows. There is no movement posterior to the knee (adapted from Smith, 1956)

The SLR should be examined routinely in all vertebral disorders, all lower limb disorders, and some upper limb disorders. The protocol suggested by Breig and Troup (1979) is followed. The leg is simply raised in the sagittal plane with the knee extension maintained.



Fig 3: Plantarflexion/inversion may be added to the SLR while the heel rests on the operator's shoulder

The sensitising additions are:

- Ankle dorsiflexion (Breig and Troup, 1979). This stresses more the tibial component of the sciatic nerve.
- Ankle plantarflexion with inversion (fig 3). This stresses the common peroneal nerve and is especially useful in the assessment of anterior shin and dorsal foot symptoms.
- Passive neck flexion.
- Increase medial hip rotation (Breig and Troup, 1979).
- Increase hip adduction (Sutton, 1979).
- Alter spine position. For example, a left SLR will be sensitised by spinal lateral flexion to the right.

Take care with the interpretation of results and remember to consider all joints, muscles and soft tissues that are also stressed with these manoeuvres.

The following example illustrates how useful logical juggling about with the test components can be in drawing conclusions about the contribution of AMT to a disorder. A patient complains of anterolateral shin pain which can be reproduced by inverting the foot and then adding plantarflexion. On the basis of this positive finding alone, a conclusion that joints and tissues of the foot or anterior compartment musculature and fascia are culpable tissues would seem reasonable. Testing standard SLR and comparing to the opposite leg may reveal slight differences in range of movement and end feel. However the most logical way to approach this with AMT thinking would be to bring on the pain (invert and plantarflex), maintain the exact position and amount of pain and then perform a SLR. A further increase in symptoms would justify a conclusion that AMT is a component of the disorder and may need treatment. The examination can be further sensitised by adding hip adduction, medial rotation or even passive neck flexion.

Prone Knee Bend

This test moves and tensions the nerves and roots related to the L2, 3, and 4 spinal segments and in particular the femoral nerve and its branches (O'Connell, 1951; Estridge *et al*, 1982). The test is performed by merely flexing the knee of the prone subject while attempting to stabilise hip and thigh. The pain response must be interpreted with caution as the PKB stretches rectus femoris, tends to rotate the pelvis forwards and thereby extends the lumbar spine. As well as spinal extension being possibly pain provocative, it also lessens the tension that can be placed on the femoral nerve, also hindering effective interpretation.

PKB with the hip in extension is no more sensitive than PKB with the hip in neutral (Davidson, 1987). However, it has been noted clinically that the symptoms of meralgia paraesthetica (entrapped lateral femoral cutaneous nerve) are better reproduced in PKB/hip extension.

Interpretation can be very difficult and will rely on subjective information unless sensitising information clearly alters the test response. These additions are:

- Cervical flexion.
- Slump in side lying (Davidson, 1987 — fig 4).
- Varying ranges of hip abduction, adduction and rotations.



Fig 4: Slump with prone knee bend. An assistant is necessary to control the many components

Slump Test

The slump test is perhaps the most important tension test linking neural and connective tissue components of the nervous system from the pons to the terminations of the sciatic nerve in the foot (Maitland, 1978, 1985; Massey, 1985).

It is a very sensitive test and must be carried out with a great deal of handling and interpretative skill. One study (Massey, 1985) showed that the slump was the most sensitive test out of all the tension tests for reproduction of back pain in 50 symptomatic subjects. It should be examined routinely in all spinal disorders (cervical to lumbar to coccygeal); most — possibly all — lower limb disorders, some upper limb disorders and certainly those which indicate the possibility of nervous system involvement.

The standard test consists of thoracic and lumbar flexion, followed by cervical flexion, knee extension, and ankle

dorsiflexion and if necessary, hip flexion produced by either bringing the trunk forward on the hips or by increasing the SLR. The test is well described by Maitland (1986).

The most authoritative cadaver study on the biomechanics of slumping the spinal canal into flexion has been done by Louis (1981). He demonstrated the directions of neuromeningeal movement in relation to the spinal canal mechanical interface (fig 5). According to Louis (1981), the

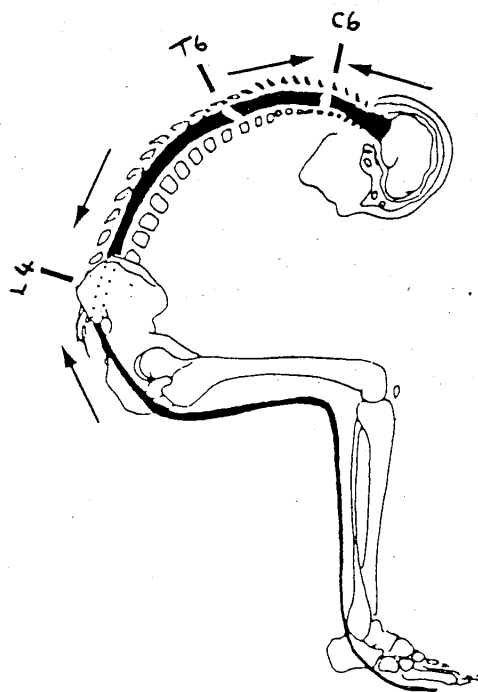


Fig 5: Movement of the dura mater and nerve roots in relation to the spinal canal during flexion. There is no movement in the regions of C6, T6 and L4 (adapted from Louis, 1981)

C6, T6 and L4 intervertebral levels are approximate levels where neuromeningeal/spinal canal relationships remain constant. Butler (1987) plays particular attention to these 'tension points' in manual joint examination when searching for possible sites of AMT of the nervous system. Again, it may only be by directing treatment to joint movement abnormalities in these areas that the effect on a presumed positive tension test can be ascertained. Thus a patient with headaches, a positive slump test and joint signs at T6 may only be helped by mobilising or manipulating the T6 joint. Vigorous attempts to alter abnormal ranges of, say, knee extension in the slump position may prove fruitless in altering the pattern of headaches unless the 'tension point' joint abnormality is addressed. Thus joint treatment can often produce impressive changes to the abnormal tension test range and also provides dramatic support to the pathological model suggested by Butler (1987).

Use of sensitising manoeuvres in the slump test are most commonly achieved by changing the position of terminal joints. It may be that lumbar and radiating thigh pain are reproduced in the full slump position. Changing the head position away from full neck flexion often results in easing if not total relief of symptoms. Similar changes in ankle and knee positions may significantly alter cervical, thoracic or head pain, thus proving the presence of AMT. It may also be clinically useful and informative to do the slump test in long sitting (ie taking up components 'from the other end').

The slump test places more tension than movement on the nervous system. Thus there is still movement available if either 'end' is released (neck extension allows more knee extension). It is likely that a SLR will bring about far more movement of lumbosacral nerve roots in relation to the MI than the slump will. Both tests should always be examined; frequently SLR is positive when the slump is negative and *vice versa*. Also, slump and SLR responses are often quite different.

The normal responses to the slump test have been examined in detail (Maitland, 1978) and the following is a summary of the research findings to which the patient response should be compared during examination:

- Pain/discomfort in mid thoracic to T9 area on trunk and neck flexion (noted in up to 50% of 'normals').
- Pain/discomfort behind knees/in hamstrings in trunk plus neck flexion with knee extension position, increased with the addition of ankle dorsiflexion.
- Some restriction of ankle dorsiflexion in trunk flexion/neck flexion/knee extension position. This restriction should be symmetrical.
- A decrease in pain in one or more areas with release of neck flexion.
- An increase in range of knee extension or ankle dorsiflexion with release of neck flexion.

The slump test is positive if it reproduces the patient's symptoms and if the reproduction of symptoms can be shown to be a result of alteration in nervous system tension/mobility. The test is even more positive if, in addition to reproducing the patient's symptoms, there is a restriction of range of movement which is asymmetrical and there is a restriction of range of one component not present when that component is tested 'out of tension'. Slump is also significant if it does not reproduce the symptoms but there is an asymmetrical range; a symptom response different from those considered normal; or a symptom response different when testing each leg, especially if combined with an asymmetrical restriction of range.

The standard slump test procedure has been described but clinicians frequently note alterations in pain responses which do not fit with a sequential increase in neural tension. Often release of neck flexion brings about an increase in symptoms, or trunk on hip flexion decreases symptoms. The concept of MI pathology put forward may help explain this in that an interfacing tissue may only contact sensitive neural tissue in such a way as to produce a reaction by the 'out of pattern' movements.

In complex and stubborn presentations, experienced clinicians may find it useful to experiment with trunk side flexion/rotation/even extension, hip abduction/adduction/rotation and differing neck positions.

Passive Neck Flexion

This test may be thought of in the same terms as a SLR, ie it takes up tension 'from one end'. Because the trunk and legs are in neutral, it allows movement of neuromeningeal tissues in relation to the spinal canal. It may be thought of as a SLR 'from the other end'. Troup (1981) emphasises how common a clinical finding it may be by revealing that 22% of all patients with back pain in an industrial survey have a positive PNF. The therapist should not restrict examination to PNF; passive neck extension, lateral flexions and combinations with other tests should be part of the AMT thinking process.

Upper Limb Tension Tests

The upper limb tension test (ULTT) has been termed the 'SLR of the arm' (Kenneally *et al*, 1988) with some justification. Credit should be given to Australian physiotherapist Robert Elvey for researching, developing and popularising this most useful and sensitive test (Elvey, 1979, 1986).

The standard ULTT (referred to as ULTT1) consists of three basic movements detailed by Kenneally *et al* (1988):

Position 1. Abduction, extension and lateral rotation of the glenohumeral joint.

Position 2. Forearm supination and elbow extension.

Position 3. Wrist and finger extension (figure 6).

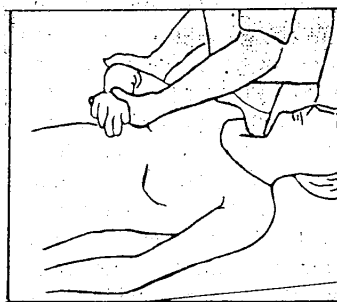


Fig 6: The ULTT1. With some shoulder girdle depression maintained, the glenohumeral joint is extended, abducted and laterally rotated, the elbow is extended, the wrist and elbow are supinated and the wrist, fingers and thumb are extended

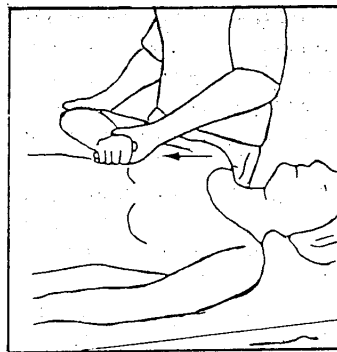
With this position held, sensitising additions are classically cervical lateral flexion away, the addition of ULTT1 on the contralateral arm, and the addition of bi-lateral or uni-lateral SLR (figure 7).



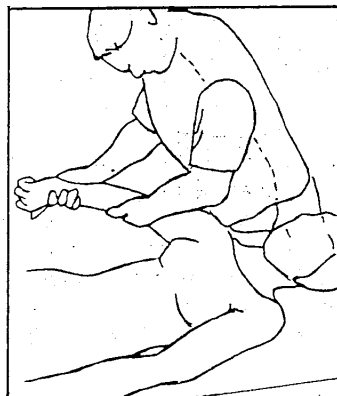
Fig 7: The addition of SLR to the ULTT1



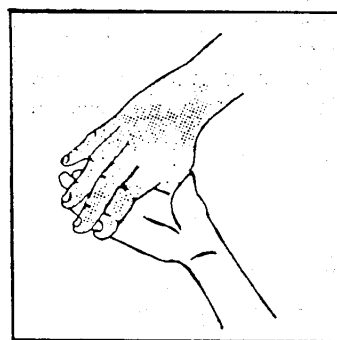
Starting position: The patient lies to the right side of the bed with the scapula free of the bed. The legs and trunk are angled to the left of the bed so that the patient feels relaxed and supported. A pillow under the head is not necessary. The examiner's left thigh rests against the patient's shoulder and his hands support the patient's arm at the elbow and wrist



Using his thigh, the examiner depresses the patient's shoulder girdle. Protraction may be examined independently or in combination with depression by the examiner slightly squatting and then 'picking up' the shoulder girdle with his thigh. The shoulder girdle may also be retracted using the examiner's thigh. After every individual movement, pain and range of movement responses should be assessed



The selected shoulder girdle position is maintained and the examiner leans towards the patient's feet and changes his grip, his right hand grasps the patient's right wrist and his left, the patient's right elbow. Movements now available to the examiner are elbow flexion and extension, shoulder internal and external rotation, and forearm supination and pronation. This figure shows shoulder internal rotation, elbow extension and forearm pronation. This is often the most sensitive position. This position allows a good view of the patient's face during testing



The selected arm position is maintained and the examiner's right hand slides down into the patient's right hand, his thumb between the patient's thumb and index finger. This allows good control of the thumb, wrist and fingers, and will also allow further supination/pronation, and radial and ulnar deviations of the wrist. In this position, the cervical spine position may be altered and the shoulder extended or abducted if needed.

Cervical lateral flexion away from test side increases arm symptoms (93%)
Cervical lateral flexion towards test side decreases arm symptoms (70%)

Fig 8: The ULTT2 — taken to the end of range

The relevant anatomy and biomechanics of the ULTT1, including sensitising additions, have been the focus of much recent attention and are comprehensively covered elsewhere (Kenneally *et al*, 1988).

During arm movements, there is a remarkable amount of

nerve movement. MacLellan and Swash (1976) observed the median nerve sliding up to 2 cm in relation to interfacing tissue in the upper limb of cadaver material during wrist and neck movements. Shaw Wilgis and Murphy (1986) noted similar nerve excursions. Arm movements also create large fluctuations in intraneural tension. Pechan and Julis (1975) recorded intraulnar nerve pressure quadrupling at the cubital tunnel in a 'manoeuvre designed to tension the ulnar nerve'. Although not studied in any detail, it is very likely that nerve 'tension points' occur at the elbow and shoulder during neck and arm movement combinations. Rubenach (1987) noted very little movement of the median nerve at the elbow during ULTT manoeuvres in a cadaver and Sunderland (1978) has suggested that where nerves branch or enter a muscle at an abrupt angle, movement of nerve is likely to be less. Just as in the spine, it is recommended that special attention is given to 'tension point' tissues and joints in examination and treatment.

A second ULTT (ULTT2) matching the work posture used in many upper limb repetition disorders has been developed (Butler, 1987). Clinically it may be more sensitive than the ULTT1 and it has frequently been observed that a patient may have one test positive but not the other. The shoulder girdle components of the test are crucial, especially depression as Smith (1956) has demonstrated on monkeys and humans and as the anatomy suggests it should be. There are no normative studies of the ULTT2 and comparison with the other arm is essential. Both ULTT1 and ULTT2 must be considered as 'base tests' for to examine pain responses and movement limitations fully, different combinations must be sought out. For example, pronation rather than supination in ULTT1 is often positive and internal rotation of the shoulder rather than external rotation may be positive in ULTT2. A patient will often demonstrate an aggravating movement or position and in examination, a combination of known tension changing movements can be added to test for the presence of AMT. The ULTT2 is described in figure 8.

Upper limb tension tests are worth examining in all patients with thoracic, cervical and upper limb symptoms even to the point of local finger pain. It is especially worth examining if the origin of symptoms is not clear from routine examination and/or the symptoms have not responded to traditional treatments.

The normal responses to the ULTT1 have been investigated in detail (Kenneally *et al*, 1988) and are summarised in figure 9.

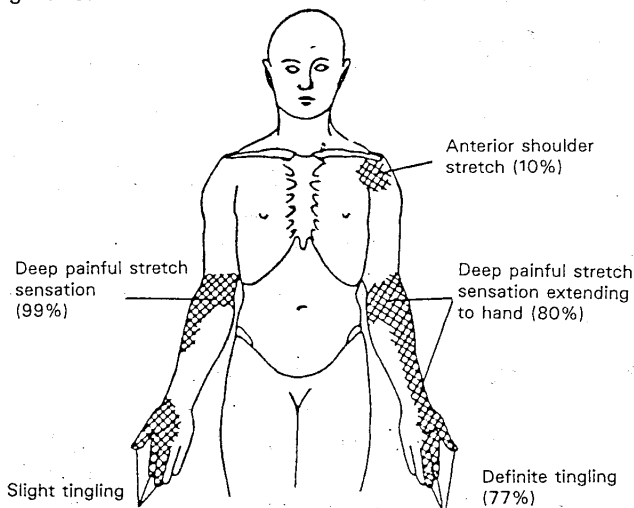


Fig 9: Normal responses to the ULTT1. Percentages are the expected incidences in normals

Precautions and Contra-indications to Nervous System Assessment and Mobilisation

Care is needed. This must be clinically expressed by clear subjective and physical assessments and continual reassessment. Existing handling skills may need development. These lists are from Butler (1989).

Precautions

1. Other structures involved in testing. For example, lumbar discs during the spinal flexion phase of the slump test, symptomatic zygapophyseal joints during the cervical spine phase of the ULTT.
2. Irritability related to the nervous system. The inherent mechanosensitivity of the nervous system needs consideration. Clinically, it appears easier to aggravate arm symptoms than leg. Irritable disorders may demonstrate latency.
3. Neurological signs. In chronic, stable disorders where nervous system mobilisation is possible, the neurological signs must be continually monitored. A neurological examination is required before any nervous system treatment is begun.
4. General health problems. Pathologies that affect the nervous system, for example, diabetes, multiple sclerosis, Guillaine Barré. Recent surgery and medical considerations.
5. Dizziness in cervical spine problems.
6. Circulatory disturbances. (In many areas of the body, the nervous system is connected to the adjacent artery.)

Contra-indications

1. Recent onset of, or worsening neurological signs.
2. Cauda equina lesions.
3. Cord signs. Physiotherapists treating via tension tests should be aware of tethered cord syndrome (Pang and Wilberger, 1982).

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The Concept of Adverse Mechanical Tension in the Nervous System

Part 2: Examination and Treatment

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Key words: Nerve, tension tests, mobilisation, manipulation, treatment, examination, straight leg raise.

Summary: Key features identifying typical signs, symptoms and history of disorders demonstrating adverse mechanical tension of the nervous system are addressed. An approach to 'musculoskeletal pain' embracing a broader outlook to all possible sources of presenting symptoms is highlighted as the 'component concept'. The treatment principles of presentations showing signs of adverse mechanical tension of the nervous system are outlined, and clarified by many clinical examples.

BEFORE embarking on a detailed method of tackling a problem using nervous system mobilisation it should be emphasised that the therapist must have a high degree of skill in musculoskeletal examination, assessment and treatment as advocated by Maitland (1986). This is central to the understanding of the approach put forward in these papers.

Treatment of neat diagnostic packages, such as tennis or golfer's elbow, does not allow thoughts of more remote culpable sources entering the treatment picture and approach.

The Component Concept

The term 'component concept' is introduced to help guide the examiner's thinking towards all tissues that could be responsible for a patient's symptoms. For example, medial elbow pain may have components arising from the medial joint capsule, the flexor tendon attachments or from as far afield as the C6 to T1 zygapophyseal joints. Components should be considered 'locally' (eg joint, muscle, etc) as well as 'remotely' (neck, shoulder, wrist joints; nerve root, etc) — see figure 1.

Figure 4 is reproduced with permission from *Proceedings of the Fifth Biennial Conference of the Manipulative Therapists Association of Australia*, Melbourne, 1987.

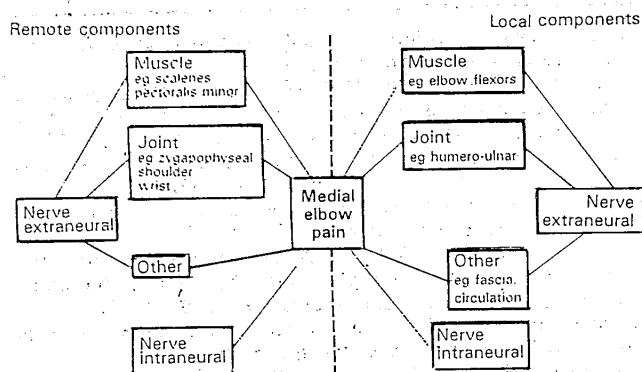


Fig 1: Possible components of medial elbow pain

The main features of the 'component' approach are:

1. Recognise and be aware of all components that are possible sources of the symptoms. The idea of thinking along nerve tracts will inevitably include more tissues from a wider catchment area than previously considered.
2. The examiner must have the skills to be able to establish whether these 'possible' sources present any abnormal signs.
3. There should be clear objective signs that can be demonstrated which are *relevant* to the patient's disorder and which can be re-tested following the application of treatment directed to a specific component. Re-testing proves the validity of a technique (Maitland, 1986).

Nervous System Components

Nervous system components can be considered locally and remotely. Local components may involve intraneural pathology (from within the nerve) or extraneural pathology affecting the mechanical interface. Remote sources must be considered either proximal or distal to the site of symptoms (fig 2).

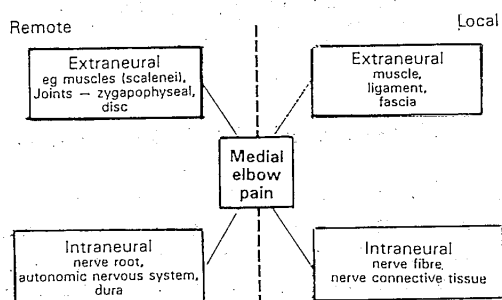


Fig 2: Nervous system components of medial elbow pain

The presence of nervous system components becomes apparent when it is established that adverse mechanical tension (AMT) is present; ie the patient has signs of an abnormal tension test (see part 1).

Identification of AMT as a Disorder Component

Subjective Examination

Symptom Area and Nature

Lines of pain may be present, often over peripheral nerves — for example, along the ulnar nerve in the upper arm, or along the sciatic nerve in the buttocks. Butler (1989), supported by Sunderland (personal communication), has

suggested that pain indicated by the patient as running in lines may be peripheral nerve referred pain.

'Clumps' of pain (Butler, 1989), indicated by the patient placing his whole hand over an area, are thought pertinent to pain originating from the nervous system. Clumps of pain are often over known 'tension point' areas.

Whole limb ache, catching pains, burning pains and even very localised 'spot' pains can be shown to have all or part of their origins in the nervous system.

The patient may use quite odd terms to describe the symptoms, eg burning, crawling, strings pulling, strangling, dragging.

Sensations of swelling, especially in the web spaces of the hand, the metacarpophalangeal row and the feet, are common complaints.

Behaviour of Symptoms

Symptoms may increase with known tension altering positions (usually nervous system lengthening), such as getting into a car, reaching up to a clothes line, kicking a football, blow drying hair.

The patient may demonstrate activity specific mechanosensitivity — for example, typing, repetitive sports or musical instrument action. It is suggested in these cases that a small segment of the nervous system has a symptomatic relationship in one distinct part of the total nerve/interfacing tissue relationship.

Pain may increase at night.

Symptoms may exhibit latency.

Symptoms may relate to interfacing tissue — eg cervical zygapophyseal closing may aggravate arm symptoms; flexed lumbar spine may increase disc symptoms.

Pain may be postural, when the patient cannot settle into a static position and continually wriggles, or sustained posture may aggravate.

History

The patient may have suffered severe trauma, such as a motor vehicle accident or falling on the buttocks. Clinically it appears that an initial tension-creating incident may have occurred years previously. Pre-tensioning of the nervous system may predispose a person to symptoms.

There may be a history of repetitious use.

Symptoms may be chronic.

The patient may have undergone previous surgery or neuromeningeal invasion, eg vascular surgery, laminectomy, myelogram, or lumbar puncture.

Other treatments may have been tried and failed. Traditional joint-based treatments may not 'get at' a nervous system component effectively.

The pain may have moved from place to place.

Objective Examination

Posture

The patient may prefer to adopt out-of-tension postures, such as slight hip flexion, abduction and lateral rotation, knee flexion and plantarflexion; cervical lateral flexion towards the site of pain; arm above the head or held in a sling.

Active Movement

Nervous system lengthening movements aggravate the pain (though shortening can also). 'Irregular patterns' of active movement can suggest that structures other than joints are involved (Edwards, 1985).

Intervertebral Movement

Passive accessory intervertebral movement (PAIVM) and passive physiological intervertebral movement (PPIVM) may

have a different 'feel' in the presence of local AMT when compared with typical joint restriction. Butler (1989) notes that this feel does not change during oscillation, has through-range resistance, and presents with a 'rubbery' kind of resistance.

Anatomical Changes

Certain anatomical features are more likely to display changes owing to their proximity to the nervous system. For example, the intervertebral joints, the scalene muscles, the first rib, the supinator, the radio-humeral and superior tibio-fibular joints, and the transverse carpal ligament.

A neurological examination may reveal changes although not in specific dermatological or myotomal distributions. Often the whole limb can be affected.

It is often possible, using the interpretation of subjective and objective examination, to identify extraneural or intraneural components of a disorder (see table).

Link between pathology, biomechanics and treatment

Nervous system adaptation to movement	Location of pathology	Passive movement treatment
Tension (pressure)	Intraneural	End range tension generation (IV)
Movement in relation to interface	Extraneural	Through range (III) Attention to mechanical interface

Treatment

The idea of passive mobilisation of the nervous system is not new. 'Nerve stretching' for a variety of complaints was a common treatment at the end of the last century. English surgeons stretched the sciatic nerve by placing a hook around the nerve at the gluteal fold and then attaching weights of around 30 lb or more for periods of up to five minutes. It was considered better to 'angle the pull downwards for neuralgia and upwards for tabes' (Symington, 1882; Marshall, 1883). The French preferred a non-surgical approach employing strong straight leg raises. The straight leg raise was applied using a 'nerve stretching' box contraption to elevate the legs (Symington, 1882; Marshall, 1883).

Besides being of historical interest, these examples do give some idea of the strength of the sciatic nerve. In the light of recent research into the somewhat complex biomechanics of the nervous system (Breig, 1978; Sunderland, 1978; Lundborg, 1988) and the important clinical focusing on nervous system biomechanics by some medical specialists, especially hand surgeons, it seems vital for physiotherapists to examine and address this aspect of 'pathology' in the presentation of day-to-day musculoskeletal problems. Physiotherapists trained in 'joint'-dominant manual therapy models such as Cyriax, Kaltenborn, early Maitland and McKenzie; or muscle-dominant approaches, such as Janda or Lewit, may need to revise their interpretations of many disorders, learn new handling skills and new concepts of progression and prognosis.

Many disorders that exhibit a significant neural tension component will also have signs of other tissue (component) involvement, for example, tight muscles or joint stiffness. It is rare to encounter a problem where the nervous system alone is implicated. It is suggested that those learning skills of nervous system mobilisation begin by focusing treatment

on these non-neural components first while observing the effect on the 'neural tension' components. It should be clear that there are hazards in placing excessive stress on neural structures especially those which are mechanically or pathologically compromised in some way. Thus, the Maitland approach using continuous monitoring of signs and symptoms with the application of each technique *has* to apply. Also, the use of the minimal amount of force concomitant with improvement in signs and symptoms is a pre-requisite if provocation and exacerbation are to be avoided.

The key to successful treatment is to consider *mobilising* the nervous system rather than just stretching it. There are three ways to consider the treatment of symptoms wholly or partially arising from the nervous system:

1. Direct treatment of the nervous system via tension tests, either 'base' tests, or tests contrived to suit the presentation.
2. Treatment via surrounding mechanical interface (MI) and related tissues. For example, the mobilising or manipulating of a cervical zygapophyseal joint relevant to symptoms in the arm that also have proved tension signs.
3. Attention to posture and ergonomic design.

Nervous system mobilising is applicable for symptoms and signs whose origins may be as a result of biomechanical compromise (pathomechanics), or irritation of some inflammatory (pathophysiological) irritation of the nervous system. It is most likely that the two exist together in the majority of cases we see (fig 3).

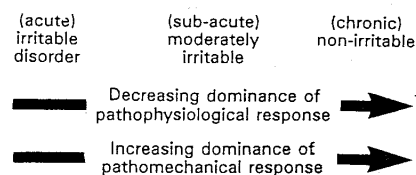


Fig 3: Relationship between irritability and pathology

One tends to envisage a situation whereby an initial mechanical insult, such as a disc protruding on to a nerve root, results in an acute inflammatory reaction and then there follows a progressive regression of the inflammation leaving extraneural fibrosis (see part 1), tethering, and a disorder of a pathomechanical nature. As well as pain, other common manifestations of neural injury, such as paraesthesia, heaviness, coldness and weakness may be successfully addressed using nervous system techniques.

It may be worth briefly clarifying the available ways in which forces can be brought to bear on nervous tissue (fig 4). Examples are given and it is suggested that this type of thinking should be going on when noting the various responses to different tension tests during examination. It attempts to bracket disorders into either 'extraneural' or 'intraneural' categories. It should be apparent that symptoms whose origins are more extraneural will be provoked more by testing procedures which produce movement than those producing tension. This has an important bearing on technique choice and mode of application (see table).

Nervous system mobilisation fits perfectly into the Maitland (1986) concept. Just as for 'joint', knowledge of the irritability, severity and nature of the presenting symptoms is essential to the initial treatment decision. The all-encompassing term 'mobilisation' encourages consideration of gentle and strong treatment, through-range and end-range techniques, movements in relation to pain and resistance, and continual re-assessment.

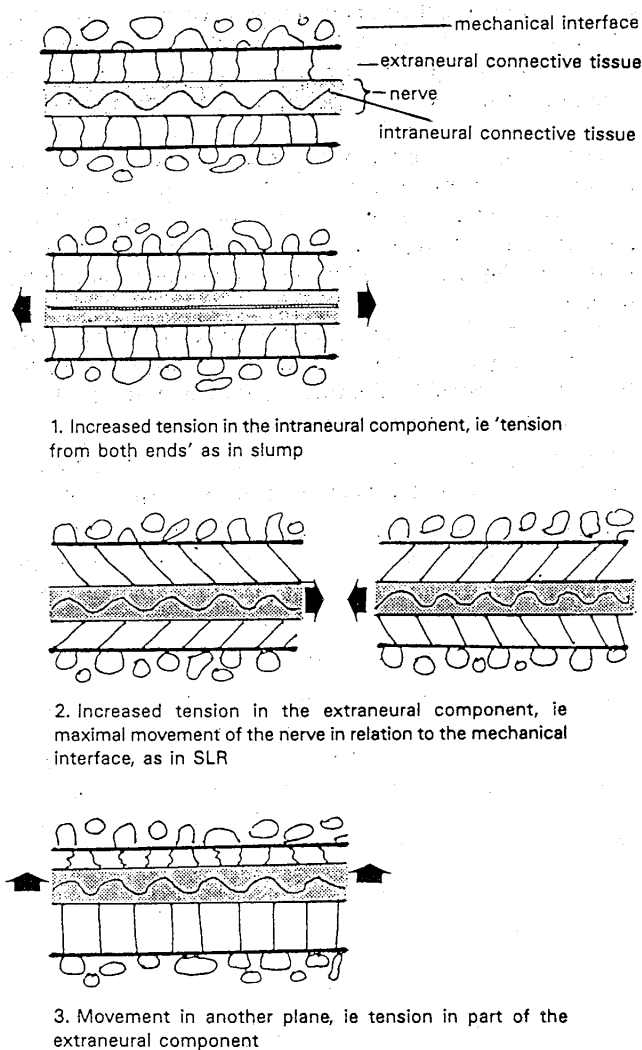


Fig 4: Diagrammatic representation of passive movements of the nervous system available to examination and treatment

Treatment of the Irritable Disorder

Some thoughts on the nature of the irritable disorder have already arisen and it is regarded here as a situation in which some sort of acute inflammatory response is the primary underlying factor. The symptoms are usually pain-dominant, of a severe continuous quality, easily provoked, and take a long time to settle down once provoked. The very nature of this type of disorder, whatever the original cause, dictates a cautious and gentle approach from the start.

Sorting out 'components' is often difficult as continuous testing stirs things up, and most tests provoke the pain anyway because even small amounts of stress are easily registered by mechanically and chemically sensitised tissues.

The beauty of examining 'nerve' components is that alterations of tension can be achieved without handling or moving the affected areas. Thus medial elbow pain may be provoked with neck side flexion away or the contralateral upper limb tension test (ULTT) being carefully applied. The combination of neck positioning and single or double straight leg raising can often provoke distal arm symptoms providing unequivocal evidence that nervous tissue components play a part in the symptom picture. Having once established the presence of AMT the therapist really has a profuse number of starting points, techniques and progressions at his disposal.

The Starting Point Technique

Whatever the starting point used in the irritable disorder, the following should apply during the first technique application:

- Tests should be well away from the symptom area.
- The technique should be non-provoking initially.
- A large amplitude technique (grade II or III) should be used if possible (it nearly always is).
- Since most interfacing tissue is muscle, maximal relaxation of the patient, and the painful areas, will allow better nerve movement.
- Monitor symptoms just as for a 'joint' treatment (Maitland, 1986). If the technique starts to irritate the pain, either reduce the amplitude/range/speed, etc, of the technique; or 'regress' the technique by re-positioning in less nervous system tension. For instance, if grade III cervical side flexion to the left was being used for right medial elbow pain; the techniques could be regressed by positioning the arm so that the shoulder girdle was in a degree of elevation and then continuing the same neck technique (fig 5).



Fig 5: IN: scapular evaluation (right). DO: cervical side flexion left

Choice of the starting point technique may appear difficult at first as there is such a vast choice if one 'thinks along the tract'. The following example may help to clarify the thinking processes involved. It takes again right medial elbow pain which is found to be provoked by positioning the right arm in neutral with slight scapula depression and then fully side flexing the neck to the left. The starting point technique now depends on how irritable the disorder is deemed to be.

Highly Irritable

Technique would be further along the tract (away from the neck and right arm) either across the midline — use opposite ULTT positions, or towards the lower quarter and legs — use for instance straight leg raise. Quite large amplitude techniques into resistance can be used, eg SLR III+, or perform left elbow extension III+ in ULTT 1 with wrist extension (fig 6).

Irritable

It may suffice here merely to release some of the tension from the examining position and perform one of the proximal components of the test in a very gentle manner. Thus, the technique mentioned earlier (fig 5) may be appropriate.

The use of these 'indirect components' away from the



Fig 6: IN: cervical neutral/arm support; left scapular depression; glenohumeral lateral rotation/abduction; wrist extension. DO: elbow extension III+

painful site may be either along the tract proximally (as above), or, distally to the area of pain. A very useful 'distal' example for acute and irritable lumbar pain is grade III+ ankle dorsiflexion which can be progressed to being performed in a position of hip/leg medial rotation (fig 7).



Fig 7: IN: hip medial rotation. DO: ankle dorsiflexion III+

Progression

The thinking clinician may now be able to realise the pleasing number of ways and infinite directions in which techniques can be applied to influence nervous system movement and tension. The following points should be considered:

Number of repetitions of technique. This may be as few as five or ten initially but can quickly be increased to many repetitions for several minutes.

Increasing amplitude and taking the technique further into resistance.

Repeat technique but alter to increase degree of tension (eg add dorsiflexion to a SLR technique, or perform cervical side-flexion with shoulder in depression).

Do a technique closer to the symptom-provoking position of the test and/or the site of the disorder. Using the medial elbow example again, a progression whereby glenohumeral abduction is used with the head in side-flexion and shoulder girdle in depression may be appropriate (fig 8). The technique could then be done with wrist extension added.



Fig 8: IN: cervical side flexion left; scapular depression; elbow extension 60°; wrist/fingers neutral. DO: glenohumeral abduction III

Nudge into pain, using smaller grade techniques (grade IV - -). Similarly, nudge into nerve resistance.

The ultimate aim of treatment is to clear *all component signs*. So far as the nervous system is concerned this means making the abnormal tension test normal in range and 'pain response' (see part 1). Existing pathology, previous injury, age, constitutional factors and extent of nerve fibre damage are considerations which dictate whether this ideal is possible or whether it is wise and safe to try and achieve.

The conversion of beneficial nervous system mobilising techniques into home exercises is easy and can be applied to even the most irritable disorders. For example, it would be a simple matter for our medial elbow pain patient to perform active SLR in a relaxed lying position or even perform this in the through-door position (fig 9).



Fig 9: Home SLR exercise. Note movement and tension are produced by extending knee while foot slides up wall

Appropriate postural advice is an important consideration.

The pathophysiological and pathomechanical effects of mobilising the nervous system in the irritable disorder can only be assumed. Elvey (1987) has postulated a physiological effect involving pressure changes within and around the nerve which may help to disperse unwanted inflammatory by-products. Salter (1989) and others have shown that early passive mobilisation of injured joint tissue is beneficial for clearing oedema and haemarthrosis, promoting healing and preventing adhesion formation. This is likely to be significant in relation to the nervous system.

Treatment of the Non-irritable Disorder

The presumed underlying features of the non-irritable disorder are that it is more of a pathomechanical nature than pathophysiological. It is also likely to be longer standing. Beware of the acute disorder which appears to be non-irritable as strong techniques frequently aggravate.

It follows that *the only way to tackle* a pathomechanical problem is to use techniques that address 'mechanics'. Bed rest, drug therapy and electrotherapy are unlikely to solve the problem completely. Surgery may have to be resorted to.

The treatment rationale suggested here is really a combination of 'Maitland's' signs and symptoms approach combined with thoughts of nerve mechanics and pathology (see part 1). It is important that the clinician has clear active, passive and subjective signs that can be monitored after each technique and between treatments. At this stage of our knowledge every 'technique' should be regarded as a hypothesis which has to be proven. It is simple logic.

The following patient example will be used throughout this section in order to illustrate the treatment approach:

A 33-year-old shop assistant has had a nagging knee problem present for eight months with no obvious reason for its onset. The pain is localised over the lateral aspect of the right knee and occasionally spreads down the lateral calf to the ankle. She is generally fit, but when questioned mentioned having been involved in a rear-end vehicle collision as a teenager but with no serious or long lasting consequences.

The pain is worse at the end of a working day (standing), and immediately provoked going up stairs and sitting with legs up on a sofa and out to the left (fig 10). Her knee has been treated extensively with electrotherapy and manual therapy with only temporary improvement.

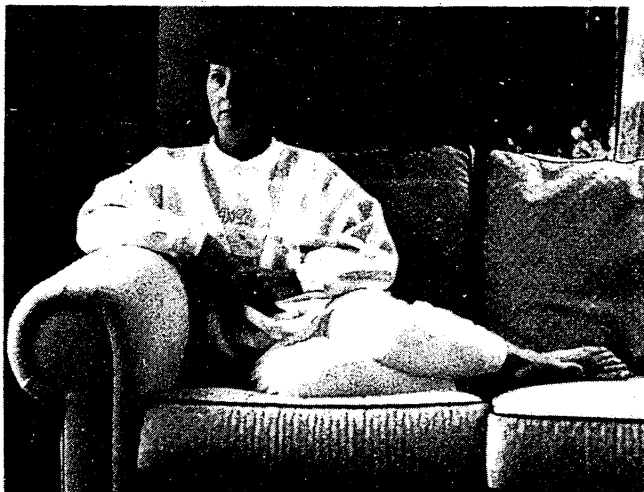


Fig 10: Patient sitting. Note lumbar left side flexion, right hip flexion/lateral rotation, right knee flexion, left foot plantarflexion/inversion

Analysis

There are three different key aggravating factors. Two *positional* (standing and sitting on the sofa) and one *active* (stairs). It seems that standing takes a good while to provoke the pain; it is therefore a useful indicator of 'subjective' progress from treatment session to treatment session. Going up stairs makes a useful active re-test following any technique.

Sitting on the sofa is useful as it involves a combination of positions of many joints and tissues and can be analysed as follows for nervous system tension components:

- Knee flexion (plus slight adduction?) = moves/tensions femoral nerve (prone knee bend — PKB), decreases sciatic tension.
- Foot plantarflexion plus slight inversion = moves/tensions peroneal nerve.
- Hip slight flexion = moves/tensions sciatic nerve. Hip lateral rotation = decreases sciatic tension.
- Spine flexion = tension increasing (part of slump). Side flexion left = moves/tensions right nerve roots/nerves of lumbar and sacral plexus.

Examination

Other Components Found

Knee: lateral ligament and head of fibula tender to palpation. Strong adduction in 10° flexion reproduced the pain.

Hip: ✓✓

Ankle: ✓✓

Spine: Active tests normal. Palpation of L3, 4, 5 to postero-anterior pressures were markedly tender and relatively immobile. T3–6 were also stiff.

Muscle: All relevant muscle tests ✓✓

Nervous System Components Found

Loss of about 10° right SLR compared to left. All sensitising additions increased the existing end-range discomfort.

PKB, like SLR, was tighter right than left.

Standard slump: Neck plus spine flexion plus right knee extension = -20° compared to left. Provokes pain over area of pain complained of but slightly different quality.

Left knee extension provokes posterior knee pain only (remember, think 'tension point'). The addition of right ankle plantarflexion inversion increases existing discomfort. Release of neck flexion by only 5° or so abolishes all the pain and full knee extension is possible. Finally the addition of left lumbar side flexion in the full slump position intensified the pain considerably and reproduced the exact pain.

So far the example underlines the need for detailed analysis of subjective information, particularly *key aggravating postures/activities*, and that *deviations* from standard tests are often necessary to make a tension test relevant to the disorder. The response and range of standard tension tests compared to the known 'normal' (knee extension -20°, pain in lower leg — slump) make useful reassessments after a technique application. It is frequently the case that standard tension tests are unrevealing. The clinician must improvise tests to fit the key features of the disorder. Sometimes it is necessary to take tension up from the 'other end' in order to hunt out a valid response. For instance in slump: Patient sits erect, head up — do ankle,

dorsiflexion plus knee extension plus hip flexion plus spine flexion and finally neck flexion. Any component of a tension test can be added in any sequence for examination and/or treatment purposes.

Starting Point Technique

In the passive movement assessment of abnormal joint and/or muscle, a close and directly proportional relationship between resistance perceived and the onset and increase of pain is frequently encountered. Final choice of technique grade is often made in terms of this relationship (see Magarey, 1985; Maitland, 1986). In nervous system disorders, abnormal resistance relevant to the disorder but which does not provoke the pain complained of is encountered, eg the SLR of -10° or the PKB restriction in the example.

Thus, the starting point technique is often into resistance but short of provoking the pain. The ideal aim of treatment is to try to establish a normal range of tension test movement combined with a normal pain response.

A grade III mobilisation provides plenty of movement with a short or low dose of tension at the end of range for a given period. Conversely, a grade IV, by definition, maintains tension at the end of range with very little movement. Far more tension than movement is employed by a IV than a grade III for the same period.

In pathological terms (see table): through-range large amplitude techniques (grade III) should be employed where abnormalities of mechanical interface biomechanics of the nerve (extraneural) are thought to be responsible for symptoms; and small-amplitude end-range techniques (IVs) where an intraneural disorder is thought likely. From the 'signs and symptoms' viewpoint IIIs are less provoking and IVs more provoking. Guide lines as stated by Maitland (1986) can be used.

Examples of mechanical interface pathology may be fibrous tethering of a peripheral nerve in its bed. Oedema in the nerve bed in carpal-tunnel syndrome, or blood in the nerve bed following Colles fracture, are further examples which could lead on to later fibrous tethering. Epineural fibrosis or oedema that has gained access inside the

perineurium are considered examples of intraneural pathology.

To go back to the example; our most likely first aim is to tackle the abnormal SLR and to then progress to clearing all other components if necessary. As pain is reproduced during tension testing by a manoeuvre providing more tension to the nervous system than movement (slump in left side flexion), intraneural pathology is most suspect. But, as the symptoms are provoked by relatively out of tension postures (standing) and movements (stairs) an extraneural component more than likely needs addressing as well. The possibility of a nervous system insult in the spinal canal, following the road traffic accident which has led to abnormal peripheral nerve mechanics in the region of the knee has to be considered as an underlying causal feature.

The two areas may need attention for the best result. It is possible that the clinician need go no further than using techniques that revolve around a standard SLR in order to clear this problem:

The most obvious starting point technique is to use the SLR employing tension development (IV), or if not tolerated for long, a quickly-on quickly-off technique. Monitor all component signs after each technique and the key aggravating activity (stairs — do a step-up).

Strength and dose of technique in all situations depends on:

1. Nature of underlying pathology.
2. Whether or not improvements are being gained.
3. How much the patient can tolerate.

Always start with minimal force for a short period or few repetitions and progress from there. It is vital that any discomfort or symptoms produced during a technique should subside completely, immediately the technique is stopped. Neurological signs should be continually monitored.

Progression

It is worth exploring techniques using SLR as a base in order to demonstrate the many available avenues to take in tackling the problem.

It appears that tension and movement are greatest at the



Fig 11: IN: hip flexion 90° . DO: knee extension III. Movement is produced by the operator side flexing his trunk



Fig 12: IN: cervical flexion, lumbar side flexion left; hip flexion 90° with medial rotation and adduction. DO: Knee extension III+



Fig 13: IN: slump; cervical flexion, lumbar flexion and left side flexion; hip adduction and medial rotation; foot plantarflexion inversion. DO: knee extension IV+

component being moved (eg in the ULTT, if elbow extension is the selected technique, more tension and movement will be happening in the nerves around the elbow than at other sites). Hence, it could be said that as a progression the component used should be as close to the *origin* of symptoms as possible. In our example, this could be the knee:

In hip flexion 90°, do knee extension (fig 11). Progress by:

- Add neck flexion to technique.
- Add left side flexion
- Add hip medial rotation.
- Add hip adduction.
- Add plantarflexion/inversion of the ankle (fig 12).

Further progression would be to use spinal flexion (ie slump) with the ultimate technique following this logic being shown in figure 13.

This 'nice' progression does not always provide the desired result. The following points should be considered:

Nervous system biomechanics dictate that abnormalities in one area of the nervous system will affect other areas. Sometimes it is necessary to clear one 'tension test' before the one being concentrated on can be cleared. Thus, attention to the abnormal PKB in the example, may be necessary before being able to achieve anything with the SLR or slump-based techniques. At other times, a slump may need to be treated before ULTT related disorders can be helped.

Attention to abnormal mechanical interface tissues — any tissues or structures which are adjacent to nervous tissue and which exhibit abnormal signs often need treating. Good examples of muscle are the scalenei and piriformis. Spinal, rib or peripheral joints may need appropriate mobilisation. A knowledge of 'tension points' (see part 1) helps the clinician to examine for relevant abnormal signs at remote sites. In the example given relevant tension points and vulnerable mechanical interface sites are:

- Superior tibio-fibular joint.
- Knee joint.
- L4 and joints above and below.
- Mid thoracic joints.

The opposite SLR produced posterior knee pain which is considered an abnormal 'tension point' response (Butler, 1988, 1989) and may need attention.

Abnormal joint/muscle components may require treatment in positions of tension. In the example, knee adduction performed in slump with knee extension is a possible and appropriate technique (fig 14). Local tender areas can be



Fig 14: IN: slump knee extension — 20°; foot plantarflexion/inversion. DO: knee adduction IV+



Fig 15: Long sit slump (one leg); ankle dorsiflexion. DO: friction of lateral ligament for five minutes

more successfully frictioned in tension (fig 15).

The nervous system does not always move parallel to the interfacing tissue. For example, the lumbar dural theca and presumably the entire dural theca moves in an antero-posterior direction during flexion and extension (Penning and Wilmink, 1981). The ULTT mobilises the cervical dura in a transverse direction. The slump treatment mobilises the dural theca in an antero-posterior direction as well as longitudinally. These thoughts should be integrated into treatment.

Transverse frictions across a peripheral nerve may be useful in restoring transverse or antero-posterior movement. This may be more so if the nerve is placed in some degree of tension and then frictioned.

Palpating along nerve trunks may assist in identifying the site and nature of pathology.

As in the irritable disorder, by using a little ingenuity, effective treatment techniques can be replicated for home exercises.

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