The Back Problem

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Logical Treatment Based On The Identification Of Cause

The symptoms of the back problem include pain, stretched ligaments, excessive wear and tear in the joints and disc prolapse. Until recently, there has been no clear understanding of cause. Available treatments have ranged from magic manipulations to flashing laser lights. All the authoritative studies show that the prognosis is much the same with or without these treatments. Year on year, the provision of ineffectual treatments has grown into a burgeoning industry. Year on year, the back problem has got worse.

The cause of the back problem is to be found in basic physical principles. To function correctly, the spine must be supple and elastic, like the spine of a healthy teenager. As the spine becomes less supple, stresses begin to concentrate at particular points in the spine during activity. Where stresses concentrate, the joints are overstressed. Back pain, stretched ligaments, excessive wear and tear and disc prolapse are the natural consequences of this overstressing.

As the spine loses supple elasticity, the joints at the lumbar-saeral junction (low back) and dorsal-cervical junction (base of the neck) become increasingly overworked and overstressed. This is why, in patient after patient, we find stretched ligaments, excessive wear and tear and disc prolapse in these areas. Idiopathic 1 enigmatic back pain is distinctive only insofar as the overstressing has yet to cause an observable degree of structural damage.

The solution is to restore supple elasticity and eliminate the overstressing of these joints. Ideally, supple elasticity should he restored before structural damage occurs. Failing that, the restoration of supple elasticity will allow healing processes to do their work unhampered by continual overstressing. If supple elasticity is not restored, the overstressing continues and the prognosis is grim.

In the absence of a clear understanding of cause, treatment has been allowed to degenerate into a mass of electrotherapy and other obscure procedures, none of which restore supple elasticity and relieve the overstressing of the affected joint. Needless to say, these therapies offer no long term benefit and no short term benefit beyond placebo.

If traditional mobilization and manipulation techniques had been adequate, then either by good luck or good judgement, the back problem would have been solved long ago. However, their limitations are fundamental.

With gross mobilization techniques, the therapist can employ their hands, strength and body weight to produce a mobilizing force. However, this mobilizing force is automatically transmitted to the nearest mobile joint. Thus, the mobile joints tend to be exercised while the fixed joints stubbornly remain fixed. Exercises designed to mobilize the spine fail for the same reason.

In focused techniques, therapists use their fingers to apply a mobilizing force directly to the fixed joints. Whilst the procedure is good in principle, it fails because the joints of the spine are much bigger and tougher than the joints of the finger. Many therapists destroy their hands in the attempt but the task is hopeless. The procedure is slow and feeble and the results are far from adequate.

The solution has been to develop a bionic hand. While the therapist retains all the sensitivity and control of their natural fingers, bionics enables the therapist to work with an energy and speed that would otherwise be impossible.

Of comparable importance is functional disorder. Traditional manipulation techniques cannot resolve conditions such as idiopathic scoliosis, kyphosis and lordosis. Abnormal curvatures and patterns of pre-rotated vertebrae have a profound effect on the mechanical efficiency of the spine and the stressing of joints. In reflex mode, the bionic fingers are employed to stimulate reflexes which cause the spine to realign automatically and with unerring accuracy. Abnormal curvatures and patterns of pre-rotated vertebrae are seen to be resolved. This advance has been made possible by the identification of the mechanism which controls the co-ordination and stability of the spine.

With a combination of mobilization and reflex modes, there is virtually no spine which cannot be restored to mechanical efficiency. The benefits are lasting. The restoration of supple elasticity eliminates the overstressing of the affected joints. This is the solution to the back problem.

The Beginnings Of Enlightenment

These researches began with a series of simple tests which proved to be most revealing. Incredibly, despite a hundred years of back pain research, there is no record of these rudimentary tests having been conducted. Had they been, then surely a clearer understanding of the nature of the problem would have followed.

It was noted that patients, complaining of idiopathic neck problems, tend to carry one shoulder high or 'hunched'. The hunch is not always marked but becomes apparent when the line of the clavicles is examined.

Patients were invited to stand with the clavicles level i.e. without the hunch. After standing like this for some minutes, they complained of tingling and loss of sensation in specific areas of the arm and hand. The tingling and loss of sensation are termed neurapraxia and indicate compression of a spinal nerve root. When distracted, patients again adopted a hunched shoulder, whereupon the symptoms subsided. Thus, by raising and lowering the shoulder, the symptoms of nerve root compression could be switched on and off.

This indicated that the 'bunched' shoulder was a protective postural response and that it acts to protect against compression of a spinal nerve root. This then raised the question as to whether this pattern was repeated with idiopathic low back pain. This proved to be the case.

Figure I illustrates the classic protective postural response which is seen when a prolapsed intervertebral disc is known to be causing root compression of a spinal nerve in the lumbar region. The response involves an involuntary muscle contraction which produces an apparent difference in leg length and pelvic tilt. In turn, this produces a lumbar scoliosis convex towards the site of root compression and acts to increase the intervertebral space surrounding the affected nerve.

The same response is found in patients presenting with idiopathic low back pain. While the response may be very marked during the acute stage of a back pain episode, it tends to be much less apparent between episodes. Nevertheless, it is readily discovered by postural measurement.

Between episodes, the patient complains of mild symptoms or no symptoms at present. In these circumstances, posture tests can be conducted. A lift is placed under the short leg so as to cause the patient to stand wish iliac crests level and the lumbar spine perpendicular, illustrated Figure II.

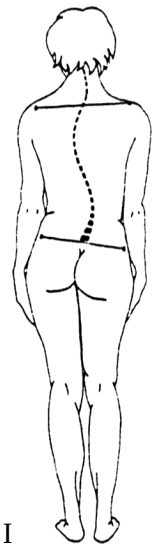


Figure I

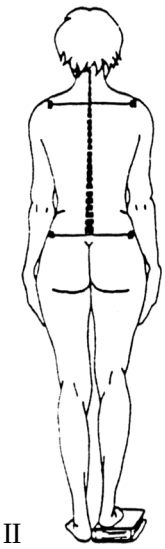


Figure II

NOTE: The scoliosis illustrated above is a function of posture and is resolved by change of posture. True scotiosis persists with change of posture.

After standing like this for some minutes, patients report neurapraxia confined to a specific dermatome, indicating root compression of a spinal nerve in the lumbar region. When the lift is removed and the patient is again allowed to adopt a scoliosis, the symptoms subside.

Given that the symptoms of nerve root compression can be switched on and off with change of posture, it follows that these patients will be vulnerable to intermittent or momentary root compression during activity.

Given that neurapraxia is confined to a specific dermatome, the affected nerve can be identified. Images can be examined, paying special attention to the disc space and the foramen surrounding the affected nerve, thus confirming vulnerability to nerve root compression in patients whose complaint is routinely described as idiopathic.

Cautiously conducted posture tests produce a mild symptom i.e. neurapraxia. However, when a protective response fails during activity, the resulting nerve root compression is liable to be severe. Activity involves imposed loads and momentum. Momentum is the most significant factor. To appreciate the influence of momentum, one only needs to consider the difference between merely resting the weight of a hammer on the head of a nail and striking the nail. The torso is, of course, much heavier than the head of a hammer. Consequently, relatively small velocities will produce a large momentum, hence the slow movements of the torso characteristic of the back pain sufferer.

Postural measurements, designed to detect and record the presence and magnitude of a protective response, can be made between and during back pain episodes and posture tests can be conducted before and after intervention. When this is done, a comprehensive picture emerges which can be summarized as follows.

Postural measurements and tests confirm that recovery from a back pain episode is attributable to protective response. They also confirm that the underlying mechanical disorder and vulnerability to root compression persist, masked by protective response. During the acute stage of a back pain episode, the protective response can be very marked. With time, it tends to diminish. As it diminishes, the patient becomes increasingly vulnerable to a fresh episode. Thus, we tend to see a series of back pain episodes set against a background of back ache and morning stiffness. The back ache and morning stiffness are a natural consequence of the muscular effort involved in maintaining the protective response.

Having established that the complaint relates to vulnerability to intermittent / momentary nerve root compression, we can turn our attention to the cause of this vulnerability.

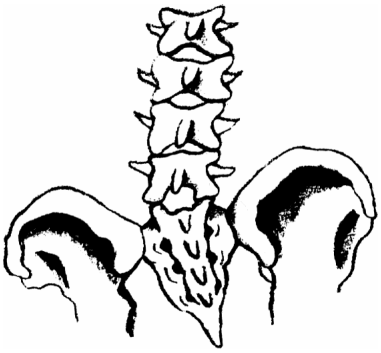


Figure III

Given that posture tests can be employed to identify the affected nerve, we can focus our attention on the relevant segment. In patient after patient, we find that this segment lies at a point of angulation illustrated Figure III. The most common sites of angulation are L3-L4, L4-L5 and L5-S1.

To understand what this angulation represents and how it may occur during some low gain activity like bending to pick up the soap in the shower, the green pages must be studied. However, it occurs because this segment lies at the focus of the concentration of stresses. The significance of the angulation is that, by virtue of geometry, it causes a further massive increase in the overstressing of the joint. It is now that the patient becomes vulnerable to nerve root irritation.

The angulation can be resolved either by traditional manipulation or, more appropriately, by the artificial stimulation of the appropriate reflex. We can now get the patient up, without twisting, and invite them to walk up and down for a few minutes. If there is a great deal of inflammation present, the benefits may take a couple of days to become apparent. However,, in most cases, the protective postural response is seen to be resolved within minutes and the patient hails a miraculous cure.

This is what is happening when a chiropractor claims to have put back a slipped disc. However, it is neither a miracle nor a cure. The benefits may last for a while in the early stages of a back pain history. However, if supple elasticity is not restored, the overstressing continues and the affected joint becomes increasingly unstable. In the end, the patient only needs to bend to get the milk out of the fridge or turn over in bed for the angulation to return. The solution is to restore supple elasticity and eliminate the overstressing of the affected joint. A higher standard of supple elasticity is required to get an unstable joint to settle down that would have been required to prevent the instability from occurring in the first place.

The therapist knows when stability has been restored because the angulation does not recur. Measurements and tests confirm that the protective postural response and vulnerability to nerve root compression are resolved and the patient remains pain free and active.

There is nothing enigmatic about the back problem. It is all a matter of elasticity, stresses and strains, geometry and reflexes. The influence of protective postural response is just one piece of the jigsaw. As with all such puzzles, the full significance of each piece only becomes apparent when the picture is complete.

A Brief History Of A Back

Stage 1 The low back is usually the first to complain of overstressing. The patient may experience a few twinges or the sudden onset of debilitating pain. The symptoms are caused by the momentary root compression of a spinal nerve. This is most likely to occur during some low gain activity like bending to pick up the soap in the shower.

The nerve root irritation triggers a protective postural response which acts to protect against further nerve root irritation. Thus, things settle down. During a back pain episode, this protective postural response can be very marked. With time, it tends to diminish. As it does so, the patient becomes increasingly vulnerable to a fresh episode. Thus, we tend to see a series of back pain episodes set against a background of back ache and morning stiffness. The ache and morning stiffness stem from the muscular effort involved in maintaining the protective response.

At this stage, the patient's complaint is termed idiopathic. In plain language this means that the overstressing has not been of sufficient severity and duration to have **yet** caused a significant degree of structural damage. However, if supple elasticity is not restored, the overstressing continues.

Stage 2 By now, the affected joint shows the classic signs of excessive wear and tear and disc degeneration i.e. narrowed disc space with some bulging, osteophyte formation or ripping around the edges of the vertebral body and arthritic changes in the small joints. The patient complains of back pain, restricted movement and sciatica and is advised to give up golf, gardening or some other cherished recreation. The patient may already be coming to terms with life on sick benefit.

However, all is not lost. If supple elasticity is restored, the overstressing is eliminated and the healing processes can do their work. Recovery can still be rapid and the benefits lasting. If supple elasticity is not restored, the damage goes on.

Stage 3 The patient may now suffer a disc prolapse (slipped disc) at the base of the neck ... that other focus for the concentration of stresses. When the neck goes., it is so miserable that the patient forgets that they ever had low back pain.

But not to worry, the patient has heard of a man with magic hands who can put back a slipped disc as easy as pie. Regrettably, these stories are pure fantasy. The mechanics and effects of traditional manipulation are well understood and have nothing whatever to do with putting back slipped discs.

To begin with, discs are principally composed of concentric rings of tough fibres which bind the vertebrae together and are not something that can slip about. However, the condition of these fibres can deteriorate to the point where the gelatinous material, which lies at the centre of the disc, can burst through this fibrous wall. This is what is meant by a prolapsed or slipped disc. It is the structural equivalent of dropping a rotten tomato on a hard floor and is not something that can be corrected by magic manipulations. Even if the nucleus pulposus could be manipulated back into the annulus fibrosus, the prolapse would promptly recur the moment the disc was put under load.

This does not mean that there is nothing that physiotherapy can do. This particular joint at the base of the neck has deteriorated because it lies at the focus of the concentration of stresses. The catastrophic structural failure of the disc does not alter the dynamics. This damaged and weakened joint is still subject to overstressing. It is small wonder that the patient is in distress. The restoration of supple elasticity eliminates the over- stressing. This provides the patient with some immediate relief and allows the healing processes to do their work unhampered by continual overstressing. While the disc will never regain its former glory, in these circumstances recovery can be rapid and lasting. However, if supple elasticity is not restored, the saga continues.

Stage 4 The patient is old before their time. We observe the characteristically slow movements of the torso and other behaviours which are designed to avoid exacerbating the pain. Sex is a problem. The patient cannot sit for long, stand for long or get a good night's sleep. They are not a lot of fun to live with. Divorce is common. Divorced with no money and no prospects, the future is looking bleak. This, combined with the constant pain, saps the strength and depression sets in. The patient is losing friends. Social life now revolves around a weekly visit to the pain clinic.

Even at this late stage, the restoration of supple elasticity will do much to improve the quality of life. On the other hand, if the overstressing of already damaged and weakened joints is allowed to continue, there is no hope except a surgical fusion. Even in the event of a fusion, the restoration of supple elasticity is indicated. Failing that, the focus of concentration is merely moved to the adjacent segment. This joint then begins to fail and the miserable saga continues.

Clearly, this picture has been painted with a broad brush. Not everyone who suffers a twinge is destined to fall apart. While, in all cases, loss of supple elasticity will result in the overstressing of particular joints, the consequences will be influenced by the degree of loss, the duration of the loss and the mechanical details.

Back Treatment In Context

Restore supple elasticity and teach the patient a simple exercise to restore postural muscles and there is nothing more the therapist can do or needs to do. Given periodic maintenance, the spine should then give a lifetime's good service.

The restoration of supple elasticity is an effective treatment for back pain because it addresses the cause of the problem i.e. the overstressing of the affected joint. However, the real solution to the back problem lies in prevention. Ideally, supple elasticity should be restored before structural damage occurs. To this end, people should be encouraged to register with a physical therapist much as they register with a dentist. Just as a little preventive maintenance does much to prolong the efficient life of teeth, so a little preventive maintenance will do much to prolong the efficient life of the. spine. After the age of twentyfive, a twice-yearly check and tune-up plus a check and tune-up following some exceptional event such as a whiplash injury or childbirth, is a small price to pay for a pain free and active life and the maintenance of youth.

Loss of supple elasticity is a natural process of ageing and affects the whole population, with genetic variations. The loss is not evenly distributed amongst the joints of the spine. Mobile joints tend to remain as mobile as they ever were. It happens that, as we get older, we tend to develop more fixed joints and fewer mobile joints.

To begin with, every vertebra is different. Some produce curvature, some have rib attachments, others are junctions between curvatures. BY the very nature of their function and design, some vertebrae are naturally more mobile than others. Moreover, every joint will be stressed differently. During activity, some joints will move first and do the most work. These joints are kept mobile while the more static joints become progressively fixed.

This natural process may be exacerbated by a modern office-car-TV lifestyle. However, while early exercise may slow or even halt the loss, exercise does not reverse the process.' During exercise, the mobile joints tend to he exercised while the fixed joints stubbornly remain fixed. In practice, exercises designed to mobilize the spine tend to exacerbate the patient's complaint.

Natural loss of mobility will be accelerated by inflammatory episodes such as may be associated with viral infections. The process will be the same as that associated with more serious inflammatory conditions. However, of far greater significance is the influence of mechanical muddles such as idiopathic scoliosis, kyphosis, lordosis and patterns of pre-rotated vertebrae. Mechanical muddle has a profound affect on the mechanical efficiency of the spine and the stressing of joints.

To understand the nature and influence of mechanical muddle one must study both the mechanism of co-ordination and the geometry of the joints. However, professionals will be familiar with the phenomenon. For example, they will be familiar with the local kyphosis or dowager's hump which may develop progressively or may arise spontaneously following a severe whiplash injury. They will also he familiar with the excessive wear and tear and disc degeneration which is observed in the joint immediately above the kyphosis.

The geometry of the joints is complex. However, a skateboard axle assembly provides an excellent model. The reader will quickly recognize the parts which correspond to the vertebral bodies, disc, transverse processes and small joint. While the assembly looks like a spinal segment, the tilt and turn geometry is identical. Examine the assembly and the reader will readily understand issues such as why spinal segments have evolved in the way they have, why mobilization by counter-rotation effectively generates mobility in all three planes and why pre-rotation effectively renders the joint static. The mechanical muddle itself is a functional' disorder. To understand the cause and nature of functional disorder and how to resolve it, the green pages must he studied.

The Mechanism of Co-Ordination / System of Nervous Control

Introduction

If one does not understand the mechanism which controls the co-ordination and stability of the spine, then one cannot understand how the spine functions. If one does not understand how the spine functions, then one cannot understand functional disorder, let alone how to resolve conditions such as idiopathic scoliosis.

The identification of the mechanism which controls the co-ordination and stability of the spine formed an essential part of the basic research which lies behind the development of power assisted micro-manipulation. Before the co-ordination and stability of the spine could he considered, it was first necessary to identify the general mechanism of musculoskeletal co-ordination. The methodology employed was as follows:

(i) Consider what the system has to do in order to produce human movement and comply with the universal laws of physics.

(ii) Identify what the system **has** to do and one has identified what the system **is** doing.

(iii) Identify what the system is doing and one has identified the system.

(iv) One now needs a deciding experiment to test the conclusion. The deciding experiment was particularly relevant. If the analysis was correct, then the -random artificial stimulation of reflexes would resolve functional disorder automatically and with unerring accuracy. In the process, abnormal curvatures of the spine and patterns of pre-rotated vertebrae would be seen to be resolved. This proved to be the case

Note: The issues are discussed at the level of school physics so as to make them as accessible as possible. If basic concepts like stress and strain are not understood, then a good dictionary will help.

Pages 6 to 10 are an extract from a previous article.

Identification Of The General Mechanism Of Co-Ordination

Because we can build robots, it is easy to assume that we know a lot about coordination. They do not, of course, share our agility and dexterity but it is easy to put this down to a lack of development on the one hand and to our complex brains on the other. However, our starting point is the realization that human movement has nothing in common with these machines.

As soon as one begins to analyse human movement, it becomes apparent the there are two distinct types of system which are capable of co-ordinated movement; normally rigid and normally passive. Our machines are normally rigid, our musculo-skeletal system is normally passive.

The mechanical excavator offers a familiar example of what is meant by a normally rigid system i.e. hydraulic rams hold the digging arm in a rigid pose until such time as it is driven to move. In contrast, our musculo-skeletal system is normally passive. Passive movement is the norm. To resist passive movement, muscular effort is required. Muscular, effort requires an act of nervous control.

Our musculo-skeletal system is normally passive because muscular effort decays if it is not actively maintained by nervous stimulation. In effect, skeletal muscles behave like hydraulic rams which incorporate a large and deliberate leak from the cylinder. The leak will cause an actuator effort to decay if it is not actively maintained. At first glance, a leaky system may appear inefficient but it offers profound advantages.

Normally rigid and normally passive systems have very different characteristics and produce different qualities of movement. A normally rigid system produces stiff or 'robotic' movement. A normally passive system is a supple system and is essential to the supple agility characteristic of man.

The control of a normally rigid system is a relatively simple matter. Relatively simple micro- processors control industrial robots. In contrast, the control of a normally passive system poses problems of awesome complexity. However, the reader need not he alarmed by the mention of awesome complexity. Evolution has found an elegantly simple solution. The solution is the mechanism of musculo-skeletal co-ordination. To understand the mechanism, we need to understand the problem it solves. In particular, we need to consider the transmission of an equal and opposite reaction.

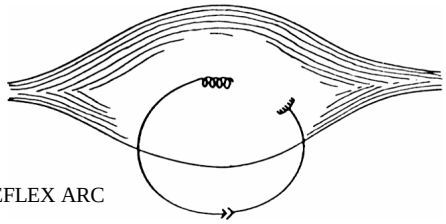
To do work, there must be an action and an equal and opposite reaction. Our mechanical excavator can tear up the ground because an equal and opposite reaction is automatically transmitted, via the rigid body of the machine, back to ground. In a normally passive or 'supple body' system, the transmission of an equal and opposite reaction is a complex problem requiring nervous control.

To do work, an equal and opposite reaction must be transmitted, via a continuous chain of muscles and levers, from object to ground. To transmit a reaction, the muscular links must resist extension. To resist extension, muscle must be stimulated by nervous control. The key question is, what is the source and nature of this nervous control?

We know that every link in the chain must be adequately tensioned. If this were not so, the action could not take place. On the other hand, we know that no link can be over tensioned. Attempts to over tension a link would cause the muscle to shorten and produce strange and unwanted movement. Since all the links must be adequately tensioned but no attempt must be made to over tension, it follows that all the links must be precisely tensioned. Precise tensioning means that the appropriate links must somehow be identified and that tensioning must take account of such complex factors as load sharing and the mechanical advantage at each link. How can such a thing be achieved? The details of each reaction will be unique to the circumstances. It follows that the reaction cannot be learnt.

Neither does the complication stop there. From anatomy, we know that the chain will follow a tortuous route involving many changes of direction. At each change of direction, the reaction will branch. Thus, the reaction will be very complex and will spread or 'flower' throughout the system. It follows that interaction between reactions arising from simultaneous actions will be of another order of complexity again. While a brain can use information gathering and processing power to coordinate action, these impossibly complex reactions are a dynamic problem and they demand a dynamic solution.

Evolution's solution is a reflex arc which causes skeletal muscle to tension in response to being stretched. The stretch reflex is well known but, due to experimental error and confusion, its function has not been recognized. The simplified illustration is included because it underlines the separateness of these reflex arcs. This separateness is pivotal to the mechanism of co-ordination.



STRETCH REFLEX ARC

A stretch reflex is more properly termed a strain reflex. Tensioning by reflex response to strain is the only means of providing for an equal and opposite reaction in a normally passive system. The appropriate links are found automatically, by reflex response to strain, since the reaction follows the strain. Each link is precisely tensioned, by reflex response to strain, since each link continues to strain until the appropriate tension has been achieved. Similarly, interactions between reactions arising from simultaneous actions are blended automatically. It will be seen that the system is self-compensating and therefore error free. It will also be seen that the system is inherently stable.

The implications of tensioning by reflex response to strain are profound. It means that evolution has solved this complex problem of inter-muscular co- ordination by the introduction of a distinct dynamic coordinating mechanism. The mechanism is distinct in that it does not rely on complex nervous inter- connection to achieve its co-ordinating role. Stress is the messenger which unites the separate reflex arcs into an integrated system.

We can now complete the co-ordination puzzle. Add this dynamic mechanism and the pieces will only fit together in one way. We have three variables under nervous control and three controlling elements, each element controlling one variable.

The three variables are muscle length, muscle tension and gain. The three controlling elements are a co-ordination of activity computer (motor cortex), a distinct dynamic mechanism (DDM) and a remote gain control (cerebellum). The motor cortex creates voluntary movement by controlling muscle length. The DDM tensions muscle by reflex response to strain. The cerebellum controls the ratio of stress to strain. The motor cortex can shorten a muscle but it cannot tension a muscle because no muscle can be tensioned in isolation. Only entire chains can be tensioned, a function of the DDM.

Reflex response to strain raises the question of the quality of that response or 'gain'. Gain alters the ratio of stress to strain. At high gain, the system will be stiff and movement sharp and strong. At low gain, the system will be tender and movement progressive and feeble e.g. prepare for an attack (high gain) … prepare

to thread a needle (low gain). Gain control and muscle tone are inextricably linked. Hence the increased muscle tone we experience with high gain.

Author's Note

Engineers have long dreamed of building a robot which can reproduce the quality of human movement, but how to do it has remained a mystery. The secret is to build a normally passive DDM system. The author has considered a normally passive DDM system built from piston type actuators and electro-pneumatic components common to industry. Analysis indicates that it will reproduce the quality of human movement and that it will respond to gain control just as we do.

If developed, the system would assist the study of many conditions which affect co-ordination and movement. For example, spasticity appears to relate to lack of gain control over the DDM The development of a relatively simple normally passive DDM robotic limb would enable this relationship to be explored in a way that would otherwise be impossible.

The Spine … Co-Ordination And Stability

It is the function of the spine to provide a supple but stable mast. Ask an engineer for a stable mast and he will give you a rod of steel. Ask him for a supple mast and he will give you a rod of rubber. Ask him for a mast which is both supple and stable and he will protest that these are conflicting demands. He may build an articulated spine supported by artificial muscles and control it with a microprocessor for a brain. However, he will only have succeeded in building a normally rigid system. There is no theoretical design which can produce the supple but stable characteristics of our spine except, that is, for a normally passive DDM system. A normally passive DDM automatically creates supple stability.

As stresses are transmitted through the spine, so the segments strain. As the spine continues to strain until the appropriate tensions have been achieved, the system is inherently stable. If the level of stress is reduced, decay automatically reduces the tension in muscles. Thus, strain controls the balance between gain and decay. It is this continuous interaction between strain, gain and decay which is the secret of supple stability.

Co-ordination in a normally passive system means something very different to the co-ordination of a normally rigid system. To drive a normally rigid spine we would need to monitor the position of each vertebra and give precise and specific instructions such as … 3rd thoracic rotate 3.75 degrees … 4th thoracic rotate 3.50 degrees … 5th thoracic rotate 3.25 degrees etc. Compare normally passive. As stresses are transmitted through the spine, so the segments strain. Thus, the segments naturally move and operate in concert (co-ordination).

This kind of co-ordination is not comparable to the geometric precision of a normally rigid system. In the course of a change of posture, different vertebrae move by different amounts in different people. Neither are these movements necessarily smooth or continuous. Nor do they need to be. Provided that the joints are sufficiently mobile, the spine will perform its proper function.

Author's Note

Before reading about altered segmental relationships it is worth taking another look at the skateboard axle assembly and noting an important difference between this assembly and a spinal segment.

Rotate and release the axle and it springs back to a central or neutral position. This is because the rubber disc behaves like a spring. An intervertebral disc is a jelly filled bog and does not have the 'spring' properties of a rubber disc. Vertebrae do have muscle attachments but muscles do not behave like springs either. On completion of a task, we do not spring back to a fixed state of attention. Muscle length and muscle tension are independent variables under nervous control. We can, for example, relax the biceps with the arm either flexed or extended or anywhere in between.

Altered Segmental Relationships

As the segments move and operate in concert, the DDM naturally acts to maintain inter-segmental relationships. We can confirm this experimentally. Observe a correctly aligned spine … invite the patient to repeatedly flex, extend and rotate the spine … re-examine the spine and note that it has remained correctly aligned. Observe a pattern of pre-rotated vertebrae … invite the patient to repeatedly flex, extend and rotate the spine then re-examine and note that the pattern of pre- rotation has remained unchanged.

However, inter-segmental relationships can be altered if the system is overcome by force or speed. There is a natural limit to the power and speed of a strain reflex. We may exceed both power and speed during some violent incident or the system may be overcome by force, during normal activity, if stresses concentrate at a particular segment. When the system is overcome by force or speed, disunited movements take place. Disunited movements alter segmental relationships. We observe these altered relationships as pre-rotation and/or abnormal curvatures.

Full unilateral rotations occur when the forces acting at a segment exceed the strain reflex's ability to resist. Unilateral rotations alter inter-segmental relationships because muscle length and muscle tension are independent variables. Muscles do not have a fixed resting length in the way that a spring has. Adopt and relax in any posture and muscle tone will automatically adjust muscle lengths to fit the geometry. Similarly, following a unilateral rotation, muscle tone will automatically adjust muscle lengths to fit the new geometry. This adjustment represents an altered inter-segmental relationship. Thereafter, the spine will continue to function. Indeed, altered relationships have no significance except that pre-rotation diminishes the mechanical efficiency of the joint.

The ability of the system to take the strain is a function of gain. Gain is necessarily adequate to the task. For example, it is impossible to lift a heavy object at low gain. However, while the overall level of gain must be adequate, it may be inadequate for a segment where stresses concentrate. In which case, the forces acting at this segment will cause a full disunited rotation.

We can now understand how it is that a man may heave his car out of a ditch without injury and yet 'put his back out' while picking up the soap in the shower. The fault is the concentration of stresses at a particular segment. The ability of this segment to take the strain is a function of gain. Prepare to lift (high gain). Relax and take a shower (low gain). In theory, we should be equally vulnerable during both high and low gain activity. However, patient histories indicate that most people 'put their backs out' during some low gain activity. The probable explanation is that we spend more time doing more with less care at low gain.

We can now understand why the avoidance of high gain activity offers no security. The only solution is to improve mechanical efficiency of the spine. We can also understand the process by which the system becomes progressively muddled. The odd incident produces the odd pre-rotation. Pre-rotation makes the system less efficient and more prone to disorder. Thus, we have a vicious circle by which complex patterns of disorder develop. By middle age, complex patterns are common.

The mechanical consequences depend as much on the pattern of pre-rotation as the number of pre- rotations. Pattern also has a bearing on the effectiveness of protective postural response. The analysis of pattern is complex and is not an essential topic since, no matter how complex the pattern, intervention is simple. Irrespective of pattern, the procedure is the same.

Stress Relieving By System Logic

The clue to scientific intervention lies in the realization that the DDM maintains the stability of the spine. From basic physical principles (vector analysis) we know that in all cases it will take less muscular effort to maintain the stability of a correctly aligned spine. It follows that the direction of least effort is the direction of order. In other words, we will correct inter-segmental relationships if we can stress relieve the system.

A sharp tap at or around the lateral end of a transverse process causes a rapid reflex movement of an individual vertebra. The principle is the same as that used to test the patellar reflex. These rapid reflex movements are of very small amplitude and very short duration but the amplitude and duration are of no consequence. The significance lies in that, in the normal course of events, the segments of the spine operate in concert. The artificial stimulation of the reflex produces an individual or disunited response. In effect, the segment is fleetingly de- clutched. It is this de-clutching procedure which allows the system to stress relieve itself.

To resolve a complex pattern of disorder, it is not enough to work along the length of the spine de-clutching the segments which appear pre-rotated. Neither is it enough to work along the length of the spine declutching each segment once. To stress relieve a network of interacting strain reflexes, a great number of reflexes must be stimulated in the correct sequence. One cannot predict what that sequence will be. However, the specialized equipment overcomes this problem.

Stress relief is a one way process. While changes of inter-segmental relationship only occur when the appropriate segment is stimulated, every change of inter-segmental relationship is a step towards stress relief. It follows that we can find the correct sequence by the random stimulation of reflexes. The principle is best illustrated by way of an analogy.

Consider a combination lock designed by an inept locksmith. Due to a design fault, the lock ignores all wrong numbers while a tumbler drops every time we pass a correct number i.e. the next number in the

sequence. Consequently, we only need to spin the dial back and forth a few times and the safe will open.

This is the principle employed in stress relieving by system logic. In reflex mode, the handset is adjusted so that all four pads are operating as rapidly moving patellar hammers. As the handset is moved up and down the length of the spine, the configuration of the pads and the speed of operation ensures that every segment is stimulated in turn. At each pass, the next segment in the sequence is found. Thus, as the handset is continuously moved up and down the length of the spine, the correct sequence is found automatically.

When the system is stress relieved, patterns of pre-rotated vertebrae and abnormal curvatures of the spine are seen to be resolved. Thereafter, the continued stimulation of reflexes effects no further change of geometry.

Combined Procedure

In mobilization mode, the pads or bionic fingers deliver alternating pressures over the lateral ends of the transverse processes so as to cause adjacent pairs of vertebrae to be worked back and forth in counter-rotation. It would be like Maitland's mobilization if only the therapist had four tireless thumbs which could work with impossible energy, accuracy and speed.

As the bionic hand is worked up and down the length of the spine every vertebra is exercised, first by counter-rotation with the vertebra below and then by counter-rotation with the vertebra above. The therapist can feel the response of every joint and even subtle changes in the texture of subcutaneous tissue. They also have touch sensitive control over the movement of the hand and the depth or grade. Combine 'feel' with touch sensitive control over all parameters and you have a bionic hand.

The bionic hand is a tool, not a machine. The high technology is there merely to provide the therapist with touch sensitive control. The skill belongs to the therapist.

At its best, the procedure is highly skilled. As they work their way along the spine, experienced therapists are continuously adjusting their touch in response to the feel of each joint. The more experienced the therapist, the more subtle the procedure. However, even in the hands of a novice, the results can be stunning.

As with all mobilization / manipulation techniques, the secret is to work with the back, not against it. The procedure is gentle, passive and progressive. It is the energy and speed of bionic fingers which makes this gentle / passive / progressive procedure highly efficient.

Clearly, one cannot achieve adequate mobility in the presence of functional disorder i.e. in the presence of mechanical muddles which we observe as excessive kyphosis, lordosis, scoliosis and patterns of pre-rotated vertebrae. Neither can one complete the stress relieving procedure and ..resolve these muddles if there is insufficient mo6ility in the joints. So as to avoid difficult physics, mobility and functional disorder have been discussed as if they were separate issues. In reality, while mobility affects the performance of the mechanism of co- ordination so functional disorder affects mobility. This interaction continues to be significant even at a subtle level. The solution is a combined procedure which involves alternating between reflex mode and mobilization mode. With a combination of these modes, there is virtually no spine which cannot be restored to the supple elasticity of youth. Without either mode, the task is hopeless.

THE FUTURE

The short term objective must be the provision of an effective treatment for common back pain. The long term objective must be the elimination of the back problem. If these goals are to be achieved, then our understanding of the mechanics of back pain must be as clear and as sound as a dentist's understanding of the mechanics of toothache. Moreover, intervention must be as purposeful as dentistry. The scientific and technical problems have been solved. The problems that remain are professional.

Many physical therapists protest that the reduction of common back pain to a rudimentary mechanical problem is simplistic. It is not. There is a clear distinction between mechanical and medical. Although comparatively rare, there are a number of organic disorders which can affect the spine. These disorders are the province of the physician. While the physical therapist may assist the physician in the management of symptoms, the underlying disorder is not mechanical and cannot be resolved by physical therapy.

The vast majority of back complaints stem from the same rudimentary mechanical problem. This mechanical / functional disorder may produce organic symptoms such as structural damage and autonomic effects. However, the underlying disorder is mechanical / functional. Mechanical / functional disorder can be and should be resolved promptly and efficiently. This is the role of the physical therapist.

Many physical therapists are truly vocational. They care only for the welfare of their patients. These therapists are delighted to find the mysteries of functional disorder reduced to purposeful intervention. Moreover, they are so committed and so involved that they take in a mass of subliminal information which comes out in the hands as knowledge. These therapists have little to learn. All they need is the tool for the job and a little technical tuition.

However, the greater number see themselves as physicians and practice according to their particular doctrine. If these therapists were to acknowledge this rudimentary mechanical problem, then they would be forced to abandon doctrine. Moreover, they see a medical 1 mechanical distinction as a threat to their professional standing. This is misguided insofar as respect sterns from proficiency not mystique. Nevertheless, where doctrine resides, science is an intrusion. The value of these doctrines is a matter of record.

The authoritative literature makes sorry reading. Consider papers such as **Efficacy of physiotherapy for musculoskeletal disorders: what can we learn from the research?** … *In order to summarize the available clinical evidence for the efficacy of physiotherapy, 400 randomized clinical trials were identified from the literature …* ***conclusion*** *… on the other hand, because of the prevalence of serious methodological flaws, it cannot be concluded that physiotherapy has no effect.*

If physiotherapy does not excel in the treatment of musculoskeletal disorders, then where does it excel? Osteopathy and chiropractic fare little better.

Disciplined investigation and doctrine make uneasy bedfellows. Consequently, rudimentary tests were not conducted and the connection between loss of supple elasticity, the overstressing of joints and intermittent nerve root compression was not made. Moreover, doctrine dulls the mind. It even dulled the realization that there must be a mechanism of co-ordination which had still to be identified. This gap was already filled with beliefs which owed no allegiance to the rigours of science. Prime examples include the chiropractic subluxation, the osteopathic lesion and physiotherapy's muscle balance.

Physiotherapists seek to explain idiopathic scoliosis in terms of uneven muscle condition and prescribe exercises to strengthen the weak side. Indeed, muscle balancing exercises are a fundamental plank of physiotherapy. However, the balance between opposing muscles is a function of nervous control, not muscle size. If it were not so, we would be incapable of movement. Condition has everything to do with peak performance but nothing whatever to do with the balance between opposing muscles. It does not take much to realize that muscle contraction and therefore 'balance' is a function of nervous control. And yet, this embarrassing nonsense is still being taught.

This would be more understandable if the exercises actually resolved functional disorders such as idiopathic scotiosis, but they do not. To resolve idiopathic scotiosis, one must address the system of nervous control. This is what the reflex mode does.

That is why stress relieving by system logic can resolve idiopathic scoliosis and muscle balancing exercises cannot. Non-existent subluxations and mythical lesions are similarly irrelevant.

Clearly, there is considerable disparity between the presentation of physical therapy and its efficacy. It is worth taking a look at how the circle is squared.

Due to the action of protective postural response, patients naturally recover from a back pain episode. The reason for the recovery was not understood but the incidence of recovery was well known. Consequently, therapists have been free to prescribe a banana. When the patient recovers, they claim it as a triumph for the banana. On that basis, bananatherapy can claim a success rate of close to 100%.

Any therapy which does not restore supple elasticity and relieve the overstressing of the affected joint is a bananatherapy. There are plenty of bananatherapies to choose from. Ultrasound and the other magic boxes of flashing lights rank among the most popular. All the authoritative studies demonstrate that the prognosis is the same with or without these treatments but this fact is conveniently ignored.

Bananatherapies can exert a powerful placebo effect. These effects tend to be short lived but when timed to coincide with a back pain episode, which is naturally self-limiting, they can appear particularly impressive to the patient. Just how impressive placebo effects can be was well illustrated by a recent study.

The extraction of wisdom teeth causes pain and swelling. Following extraction, ultrasound was used to treat the affected area. A 40% reduction in pain and swelling was observed. This is very impressive. However, the experiment was then repeated with the ultrasound unit modified so that the lights flashed but there was no output. The results were just the same.

In the hands of a good clinician, placebos can be a powerful tool. The 40% reduction in pain and swelling was real enough. In the hands of a bad clinician, placebos can be damaging insofar as the patient is persuaded that they have received the appropriate treatment. If supple elasticity is not restored, the overstressing continues. Money for old rope is not an appropriate criteria for connecting patients up to whatever piece of electrotherapy equipment happens to be available.

When introduced to power assisted micro-manipulation, a depressingly common reaction is "Do you mean you have to stand and hold it?" The short answer is no, you do not stand and hold it, you work your socks off. Even with power assistance, the restoration of supple elasticity is hard work. It is upon discovery of what hard work it is that one hears "We're making a good living with things as they are."

Frustration was sure to breed some degree of cynicism. It must be difficult to remain motivated when the vast majority of the demand for your services are 'backs' or back related problems and you have no effective treatment. Nor is this problem confined to the orthodox school of physiotherapy. The distinctions between physio-therapists, osteopaths and chiropractors are greatly exaggerated. Many physiotherapists employ manipulation techniques pioneered by osteopaths and chiropractors. Many osteopaths and chiropractors use ultrasound and other adjuncts pioneered by physiotherapists. These days, one may observe greater differences between one physiotherapist and another, one osteopath and another and one chir6practor and another, than between physiotherapist, osteopath and chiropractor. This is hardly surprising given that physiotherapists, osteopaths and chiropractors are faced with the same problems.

Present a therapist with an ex-rugby football forward, built like a brick outhouse, head protrudes from the front of the chest level with the shoulders and dorsal spine set like cement. What is the therapist supposed to do? Without power assistance, the task is hopeless. Slight patients with plank-like backs can be even harder work than the kyphotic giant. Moreover, how was the therapist supposed to resolve conditions like idiopathic scoliosis and excessive kyphosis and lordosis? With muscle balancing exercises? Traditional manipulation can be employed to make adjustments like the reduction of the angulation described in the section on posture tests and this may deliver some temporary benefit but it cannot resolve functional disorder.

Individual therapists are not responsible for the late arrival of an effective treatment. They are not mechanics. Few even understand the distinction between stress and strain. Moreover, this advance would not have been possible without the identification of the mechanism of co-ordination. It was not for the therapist to solve an intellectual puzzle that had confounded generations of scientists and robotics engineers. Nor was it for the therapist

To undertake the hi-tech engineering that was involved in the development of the bionic hand. Nevertheless, the facts remain and they are as follows:

(i)The back problem is a rudimentary mechanical problem.

(ii) This rudimentary problem has been very costly both in financial and in human terms.

(iii) Ignorance and bad practice are part of the problem, not part of the solution.

The appalling back pain statistics are a legacy of a branch of medicine which, for far too long, has been sheltered from the rigours of science, bolstered by doctrine and excused by low patient expectation.

There are enough vocational physiotherapists, osteopaths and chiropractors to ensure a revolution. As the numbers using power assisted micro-manipulation grow, there is a corresponding growth in public awareness. To date, every effort has been made to avoid publicity. This has been done to prevent all concerned from being swamped by demand. However, as public awareness grows, the avoidance of publicity is becoming increasingly difficult. It is only a matter of time before a documentary is made. The public will then know the truth of it and that will mark the beginning of the end of the back problem.

However, a better way is to conduct an independent investigation which is designed to nail the mechanics of the problem and the mechanics of the solution to the wall. The profession will then he in a position to provide leadership. It will do much to restore and preserve public confidence if the profession present as the architects of progress rather than the butt.

It is for the mechanic to work out the mechanics of the problem and the mechanics of the solution. It is for the mechanic to develop the tool for the job. It is for the clinician to make clinical reports. It is for the profession to put its house in order.

Evaluation

There are many difficulties associated with a statistical study. For example, due to the action of protective postural response, patients will recover from a back pain episode at much the same rate with or without treatment. On the other hand, the majority of chronic back pain sufferers have long since given up hope of finding an effective treatment and have dropped out of the system. A disproportionate number of those that remain in the system do so to qualify for disability benefit. At their age and with their record, they have little prospect of finding lasting employment. These patients live in fear of being declared fit to work and the consequential loss of benefit. This is not statistically fertile ground.

To be of value, a statistical study would need to be of an extended nature and the participating patients would require a maintenance treatment every six months. The control group would be sure to learn of an effective treatment and would be free to seek the appropriate treatment privately. Many back pain patients are desperate and few would elect to continue their suffering. As a consequence of these and other difficulties, the study would not be truly randomized and would be blind to neither clinician nor patient.

A flawed statistical study is a waste of time and resources. In the final analysis, there can he only one statistically satisfactory trial, one satisfactory criteria and one satisfactory outcome i.e. the elimination of the back problem.

The efficacy of procedures such as hip replacement, dentistry and power assisted micro-manipulation stem from a clear understanding of the mechanics of the problem. Thereafter, it only remains to observe that intervention resolves the problem. There will be placebo effects associated with every procedure. However, these effects only become significant when at the margins of benefit and when the benefits are short lived. In these circumstances, evaluation means:

(i) Observe objective tests and other matters which confirm the mechanics of the problem.

(ii) Observe that intervention resolves the problem.

(iii) Observe that the benefits are substantial and lasting.

The bionic hand is a tool just as a scalpel is a tool. Conduct a trial on a scalpel and it will tell you a great deal about the knowledge and skill of the surgeon but very little about the quality of the tool. And so it is with power assisted micro- manipulation. The quality of the tool is self- evident. It does precisely what it is supposed to do. The issue is the knowledge and skill of the therapist.

The value of trials lies in the contribution they can make to the dissemination of knowledge and skill. To be of value, trials must be an examination process which nails the mechanics of the problem and the mechanics of the solution to the wall.

Of the resources devoted to back pain research, a wholly disproportionate amount has been consumed by statistical studies of one sort or another. These studies have contributed nothing to the solution. Of the remaining resources, a disproportionate amount has been consumed by studies in the psychosocial aspects of back pain. Whilst these studies may tell us something about the way people cope with pain and disability, they tell us nothing about cause.

If cars were prone to axle failure, we would be astonished to learn that engineers had spent most of the research budget comparing the incidence of axle failure in red cars and blue cars. Moreover, we would be singularly unimpressed to discover that the rest of the budget had been spent trying to decide whether or not the psychological profile of the driver was a predictive factor. In reality, the engineer would examine the failing component and identify overstressing as the problem. The engineer would then identify the cause of the overstressing and come up with a solution. If the solution involved routine maintenance, owners and mechanics would be advised accordingly.

And so it is with the spine. The problem relates to the overstressing of particular joints. The cause of the overstressing is lack of maintenance. If the spine came with a manufacturer's warranty, then after the age of twenty five, a short service every six months would be a condition of that warranty. The spine should then give a lifetime's good service. Failing that, the restoration of supple elasticity is the best that biomechanics can offer.

Needless to say, attention needs to concentrated on the problem and its solution. Psychologists and statisticians can then complete their studies, flawed or otherwise, long after biomechanics have brought the problem under control.