

Locomotor Slings: a New Total Body Approach to Treating Chronic Pain *By David Wadsworth*

In this article, David Wadsworth introduces a model for the examination and treatment of chronic myofascial dysfunction known as 'Locomotor Slings'.

Locomotor slings is a model which recognises that muscles and their investing fascia are frequently interconnected, with fibres blending from one muscle to the next. Groups of muscles and their fascia may be related by direct anatomical continuity, whereby a chain of muscles and their fascia are interconnected in a relatively continuous line. This chain of anatomically interconnected myofasciae is known as a 'myofascial sling'. Alternatively, some chains of myofasciae are related functionally, meaning that they are almost always activated together to perform a motor task. These chains of myofasciae are called a 'locomotor sling'. Both myofascial and locomotor slings consist of a chain of myofasciae spanning either a region of the body or from head to toe. They are involved in controlling both posture and movement. Consequently, when examining and treating abnormal posture and motion, clinical results may be improved by understanding the inter-relationships and organisation of myofasciae into slings.

The Locomotor Slings approach provides an ideal model for practitioners of structural balancing and is complementary to existing models of clinical examination and treatment. The concept of a Locomotor Sling was created in an effort to explain why some groups of myofascial structures have a tendency to become tight, in order that treatment may involve not only improving the flexibility of these structures but also identifying and managing the underlying cause of the tightness.

When considering the muscular system, its investing fascia is often neglected. This is surprising since fascia is a substantial structure that is inseparable from and in fact adherent to the underlying muscle. Thus it is impossible to palpate or otherwise manipulate muscle without influencing its overlying fascia and vice versa. Consequently a more appropriate term for the muscle-fascia unit is myofascia.

Fascia is primarily a collagenous sheet of tissue and has been shown to contribute significantly to muscle function. For example, Garfin and co-workers (Garfin et al., 1981) demonstrated that simply incising the fascia reduces muscle strength by 15 per cent. Like muscle, fascia is richly innervated with mechanosensitive and nociceptive nerve endings (Yahia et al., 1992), suggesting that it also has an important sensory role. Thus fascia is not simply a passive structure present without purpose. It can adapt and remodel in response to stress in order to better meet the demands placed upon it.

One of the interesting features about the myofascial system is that contrary to popular anatomical descriptions in which muscles are generally portrayed as having a unique and localised origin and insertion, muscles do not always insert onto a single unique location separate from all other muscles. Muscles frequently appear to have some fibres which blend across to the adjacent muscle, fascia or ligament. The fascia itself always blends with and is anatomically continuous with adjacent fascia. In fact, fascia is continuous throughout the human body (Juhan, 1987). A well studied example is the continuity between fibres of the plantar fascia of the foot and the Achilles tendon (Snow, Bohne, DiCarlo, & Chang, 1995), where collagen fibres have been shown to be continuous across the posterior

calcaneum (Figure 1). Similarly, it has been well documented that the biceps femoris muscle frequently attaches not only to the ischial tuberosity but also to the adjacent sacrotuberous ligament (Vleeming, Stoeckart, & Snijders, 1989). Stripping of the investing fascia during dissection starts to strip away the interconnectivity that is otherwise readily apparent between adjacent myofascial and other connective tissue structures.

The functional significance of these interconnections has been investigated but is not yet fully understood. For example, it has been shown that mechanical tension applied to the biceps femoris muscle is transferred to the sacrotuberous ligament to which it partially attaches (Van Wingerden, Vleeming, Snijders, & Stoeckart, 1993). In another example, a myofascial continuity has been described between the gluteus maximus muscle, the thoracolumbar fascia (TLF) and the contralateral latissimus dorsi muscle. Traction applied to the gluteus maximus muscle has been shown to be transferred across the TLF to the contralateral latissimus dorsi muscle (Vleeming et al., 1995). While it appears that studies such as these have established a biomechanical continuity between adjacent myofasciae, the significance of the shared fascia in terms of its sensory role has yet to be investigated. It is possible that the overlapping sensory supply may have a role in co-ordinating activity between related myofasciae.

Myofascial Slings

The direct continuity and linked function between adjacent myofasciae has led to a series of 'semi-continuous' muscles and other connective tissue structures being termed Myofascial Slings. A number of authors, including anatomists, and

Table 1. Differences between Locomotor and Myofascial Slings.

LOCOMOTOR SLINGS	MYOFASCIAL SLINGS
Myofasciae are grouped based on functional co-activation during motion. Myofasciae may or may not be in direct anatomic continuity.	Myofasciae are grouped based on direct anatomical continuity. Fascia from one structure blends in a relatively straight line to the next structure.
Entire sling is activated for movement	Rarely is the entire sling activated during movement
A single locomotor sling does not span the entire body	A single myofascial sling may run from head to toe
Used in the assessment & treatment of movement dysfunction	Used in postural analysis and structural balancing
Treatment is with exercise therapy	Treatment is with myofascial release and stretching

clinicians interested primarily in either exercise therapy or manual therapy have noted these direct anatomical connections (Myers, 1997a; Pool-Goudzwaard, Vleeming, Stoeckart, Snijders, & Mens, 1998; Vleeming et al., 1995; Vleeming et al., 1989). The classification of muscles as a myofascial sling is based on longitudinal connections between adjacent myofasciae, such that the line of fibres is relatively continuous from one structure to the next rather than bending at acute angles. Thomas Myers, a Rolfer interested in structural balancing, has published a number of works which outline in detail the cardinal myofascial slings (Myers, 1997a, 1997b, 2001). Myers names the four major myofascial slings of the trunk the Superficial Back Line the Superficial Front Line, the Lateral Line, and the Spiral Line.

Examination of the body from the perspective of myofascial slings is particularly useful for practitioners interested in structural balancing. Structural balancing, also termed structural integration, may be defined as correction of postural abnormalities via manual therapy directed at the soft tissues of the body. Although no single model of examination and treatment is able to unravel all of the complexities of human posture and motion, the locomotor slings approach does provide the practitioner of structural balancing with a practical and systematic method of assessing and treating postural faults. If only the four cardinal trunk lines are used, a reasonably comprehensive approach to managing postural faults in the frontal, lateral and transverse planes is possible. Knowledge of other slings, such as the Deep Front Line (Myers, 2001), provides further skills to the examination and treatment of myofascial tightness.

An important question to ask when

using a myofascial slings (or any other) approach is ‘Why did these structures become tight?’ Simply releasing a restriction is inadequate unless the cause of that restriction is identified and managed accordingly, otherwise it is likely that the restriction will recur. Recalling that myofascia is a dynamic tissue that is able to respond and adapt to its environment, it is likely that the two major causes of tightness in myofascial structures are excessive muscle activity or maintaining the myofascia in a shortened position (Janda, 1985).

It is at this point where a major limitation of using myofascial slings alone as an approach to structural balancing becomes apparent. One of the limitations is this – it is rare to see an entire sling become tight from head to toe. More commonly, only a portion of the sling becomes tight, and in particular it tends to be that part of the sling which is functionally activated to a greater extent than other muscles in that particular individual. In the muscle imbalance model for examining motion and posture, muscles which are overactive tend to become tight, whilst those muscles that are underactive tend to become weak (Janda, 1985). These observations lead to a new concept, the Locomotor Sling.

Locomotor Sling

A locomotor sling refers to a group of muscles which are involved in performing a common motor task (locomotor = locomotion or movement), whereas a myofascial sling refers simply to a chain of muscles which are anatomically

interconnected without necessarily being functionally related (Table 1). This means that the muscles involved in a locomotor sling are not necessarily in direct anatomical continuity but their function is inextricably linked. It also means that a sling may be both a myofascial and locomotor sling. For example the anterior oblique sling (Pool-Goudzwaard et al., 1998), which consists of the external and internal oblique muscles, functions as a locomotor sling in trunk rotation where both muscles are always co-activated. However, these muscles are also anatomically continuous via the linea alba and thus constitute a myofascial sling. Myers (2001) describes a much larger myofascial sling known as the spiral line which includes both obliques as part of a larger sling.

An example to illustrate the difference between a myofascial and locomotor sling is useful, and helps to explain why only part of a myofascial sling becomes tight. In this example, we examine frontal plane posture, and focus on the pelvis. When examining static posture for the purpose of structural balancing, the lateral line is analysed as imbalance (tightness) between the left and right sides may alter frontal plane symmetry. However the muscles involved in this myofascial sling are rarely activated together as an entire unit. If they were activated simultaneously during walking, we would waste an enormous amount of energy bending side to side with every step. During walking, which is the motor task most commonly requiring activity in the lateral line, only sections of both lateral lines are active. During stance

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Figure 1: Direct anatomical myofascial continuity between the plantar fascia and the tendo Achilles via collagenous fibres across the calcaneum

phase, the ipsilateral hip abductors are active together with the contralateral side benders of the trunk (such as quadratus lumborum and the lateral abdominals) in order to provide frontal plane stability to the pelvis. This locomotor sling has been termed the lateral muscular corset to distinguish it from the lateral line.

In the lateral muscular corset, the most common abnormality observed clinically is that of weakness of the hip abductors (particularly gluteus medius), with compensatory overactivity in the contralateral trunk side benders during gait. A possible consequence of this movement pattern which is commonly observed is tightness in the overactive trunk side benders. This myofascial shortening may in turn lead to postural deviations in the frontal plane, for example side bending of the lumbar spine with or without elevation of the pelvis on the side of tightness. Consequently during treatment, myofascial release applied to the tight trunk side benders may be beneficial, but is more likely to be associated with long term success if weakness in the opposite hip abductors is

also addressed. In this way locomotor slings form a useful concept to guide rehabilitation, by encouraging the clinician to examine all muscles in the sling relevant to the motor task being performed and identify which are weak and which are tight.

The example above also illustrates what appears to be a consistent clinical observation, that dynamics determine statics. In other words, how we move determines which muscles are habitually activated and have a tendency to become tight, and which muscles are uncommonly activated and are associated with a tendency to become weak. The resulting changes in muscle tone and length may then affect resting posture (Janda, 1985). In the locomotor slings model, those muscles habitually activated in a locomotor sling tend to become tight and affect resting posture. When examining resting posture, which in this model is used to identify shortening in myofascial slings, it is common to note shortening only in sections of the myofascial sling corresponding to those muscles habitually overactive (as part of a locomotor sling)

during movement. In other words dysfunction in a locomotor sling appears to cause tightness in that section of the myofascial sling where both slings overlap. It is for this reason that the model was named locomotor slings (rather than myofascial slings) as movement patterns appear to have a dominant influence over posture.

For practitioners of structural balancing wishing to utilise the Locomotor Slings approach, there are five stages to the examination. Initially a detailed evaluation of entire body posture is made, with the planes in which any deviations occur being noted. Any deviations from the ideal are then considered in terms of which myofasciae may be tightened to cause the observed deviation, and which myofascial slings the potentially tight muscles belong to. As a second step, muscle length tests and palpation of suspected areas of tightness are performed to measure and confirm the initial observations. Examination of other myofascial structures in the relevant sling is also performed.

A third step is appropriate to include in the examination for those practitioners trained in movement analysis. This step requires observation of common movement patterns relevant to the patient, for example the gait pattern. Any abnormalities in muscle activity are observed and noted, and considered in terms of which locomotor sling may be dysfunctional. If indicated, individual muscles or complete locomotor slings are then tested for strength or activation.

The fourth step involves relating the observed fault(s) to the patient's presenting complaint. The key question which must be answered here is whether the faults observed may be responsible for biomechanical overload of the painful region. The final step involves treatment

directed at the dysfunctional myofascial sling (myofascial release) or locomotor sling (motor retraining). The effect of treatment on posture, motion and the patients' symptoms is then reassessed, in effect bringing the clinician back to step one.

The locomotor slings approach offers a number of advantages when examining and treating patients. These include an emphasis on identifying causes of biomechanical overload rather than local symptoms (cause versus effect), total body analysis in order to identify causes that may lie remote from the site of symptoms, and manual therapy treatment (or rehabilitation) targeted at groups of muscles that are functionally related. An interesting and as yet unexplained advantage of approaching treatment of the body from the standpoint of locomotor slings and myofascial interconnectivity is the observation that releasing one part of a sling has the potential to affect flexibility throughout the entire sling. For example, a consistent observation has been that releasing the plantar fascia, a component of the Superficial Back Line, is almost always associated with an increase in the ability to forward bend to touch the toes. In other words, releasing part of the superficial back line may result in increased flexibility of the entire sling. This observation may be used clinically in cases where a particular myofascial structure is difficult to release (for example, the hamstrings in the Superficial Back Line), in that releasing another part of the sling to which it belongs (such as the plantar fascia) may in some cases assist in release of the recalcitrant muscle.

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