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HYPOTHESIS

A theoretical framework for the role of fascia in manual therapy

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Summary A theoretical framework for the role that fascia may play in apparently diverse passive manual therapies is presented. The relevant anatomy of fascia is briefly reviewed. Therapies are divided into myofascial ('soft tissue') and manipulative ('joint-based') and comparisons are made between them on a qualitative basis using measures of pain, function and 'autonomic activation'. When these three outcomes are evaluated between therapies it is observed that they are usually comparable in the quality, if not the quantity of the measures. Viewed from a patients' perspective alone the therapeutic benefits are hard to distinguish. It is proposed that a biologically plausible mechanism which may generate a significant component of the observed effects of manual therapies of all descriptions, is the therapeutic stimulation of fascia in its various forms within the body. Such considerations may help explain why diverse therapies apparently give comparable results.

Introduction

Aims and objectives

There are many manual therapies available for patients to choose from with considerable variation between techniques. This paper considers these techniques as being divided into 2 basic groups, with joint-based referred to as 'manipulative techniques' on one hand and on the other localised working of skin and connective tissues referred to as 'myofascial techniques'. Manipulative techniques may be characterised by the application of a high velocity low amplitude (HVLA) thrust or repetitive joint motion (mobilisations) characteristic of chiropractors, osteopaths and some physiotherapists, whereas myofascial therapies are considered to affect the 'static' tissue in between the joints and include a number of therapies such as osteopathic soft-tissue techniques, muscle energy techniques (MET) and Rolfing.

At this point we make a distinction in the hierarchy of respectively, techniques, systems and professions. Taking techniques first, whilst definitions vary between authors

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(for example, see Farrell and Jensen, 1992 on manipulations and mobilisations) techniques form the core repertoire of treatment options available to the manual therapist. Systems (for example, chiropractic or structural integration) may be considered to be philosophical or methodological approaches to diagnosis and treatment with manual therapy and generally claim to have unique features which distinguish them (for a review, see Coughlin, 2002). Finally, manual therapy is not exclusive to any profession (Farrell and Jensen, 1992) and each profession may have associated with it a variety of approaches and techniques. In this paper we restrict ourselves to consideration of techniques as it is through the technique that the therapeutic intervention is delivered to the patient. The perspective of the patient is important, because they are the recipients of the techniques irrespective of the system or profession from which they have originated, and practitioners of all therapies regard the welfare of patients as the highest priority.

This paper considers that there may be common elements between apparently diverse techniques, by linking the anatomy of fascia with the mechanisms thought to lie behind therapies. It is not intended to be a comprehensive review of the available literature, and the research referred to is used to illustrate the ideas in the paper. Its aims are to provide a testable framework within which therapies may be compared and to promote discussion amongst clinicians and researchers about apparent distinctions and similarities between therapies.

Method

The literature on the anatomy and properties of fascia was reviewed together with the literature on selected manual therapeutic techniques and their outcomes. Databases (AMED, CINAHL, DC Consult, ICL, ISI, MANTIS, Pubmed), Google Scholar and journal websites (Elsevier ScienceDirect and Wiley SpringerLink) were searched using keywords and for authors known to actively publish in the field.

Anatomy of fascia

This section briefly describes some features of fascia of relevance for this paper. An excellent general summary of the anatomy of fascia is given by Cantu and Grodin (2001).

Fascia is intimately involved with the autonomic nervous sytem (Barnes, 1997; Schleip, 2003a). Staubesand in 1997 reported by Schleip (2003b) found both myelinated and unmyelinated fibres in fascia, probably of autonomic origin. Stecco et al. (2008) found that the outer layers of the limb deep fascia contained a rich vascular and nerve supply with intrafascial nerve fibres seen throughout the deep fascia. They also observed Ruffini and Pacini corpuscles, confirming the earlier findings of Yahia et al. (1992) in relation to the lumbodorsal fascia. There were also small nerves oriented perpendicularly and attached to the collagen fibres which they presumed to be stretch receptors, but they also found some small nerves which displayed the morphological characteristics of autonomic nerves, agreeing with the earlier work of Staubesand. Table 1 summarises the fascial mechanoreceptors (after Baldry et al., 2001; Cantu and Grodin, 2001; Graven-Nielsen et al., 2004) and Figure 1 illustrates these receptors and their responses.

The fascial network of collagen and ground substance is maintained by fibrocytes. It is known that fibrocytes regulate interstitial fluid volume and pressure (McAnulty, 2007) as well as the extracellular molecular components and thus the composition of ground substance. It is also known that fibrocytes respond to mechanical stretch through mechanotransduction as described by Ingber (2003) and others (Chiquet et al., 2007; Eagan et al., 2007). Langevin et al. (2005) verified the mechanism of mechanotransduction (in relation to mouse tissue) *in vivo* i.e. that applied mechanical stress induces a change in cell morphology but found that the timescale in which the fibrocytes responded was in the order of 2 h. Barnes (1997) however notes that when performing myofascial release the response is felt in 90–120 s, and therefore any matrix adaptations initiated by a change in mechanical stress apparently take too long to occur to explain the observed immediate benefits of mechanical therapies. Fibrocytes may further transform themselves into myofibroblasts (Hinz and Gabbiani, 2003) through this mechanical tension, as observed in wound healing. However, myofibroblasts also appear to be a *normal* component of fascia (Schleip, 2003b reporting Staubesand in 1996) and importantly they are also observed additionally in epimysium and perimysium (Schleip et al., 2006). The contractile nature of these cells appears to give them ability to alter tissue tension, through

Table 1 Fascial mechanoreceptors affected by pressure.

Fibre Type	Location	Characteristics
Aβ (Type II)	Many types of endings in skin. Pacini and Ruffini corpuscles in superficial and deep fascia.	Large diameter myelinated fibres including Pacini corpuscle (vibration) and Ruffini corpuscle (steady stretch).
Aδ (Type III)	Skin, muscle and superficial and deep fascia.	Small diameter myelinated fibres with a high threshold, some of which may respond to heat. Conduction speed is slower than Aβ fibres. There are 2 subgroups of fibres, one having a high threshold to mechanical stimuli but others responding to light pressure.
C (Type IV)	Skin, superficial and deep fascia.	Unmyelinated fibres with multimodal receptors affected by chemical, mechanical and thermal stimuli. As with type III fibres there are 2 subgroups having high and low mechanical thresholds.

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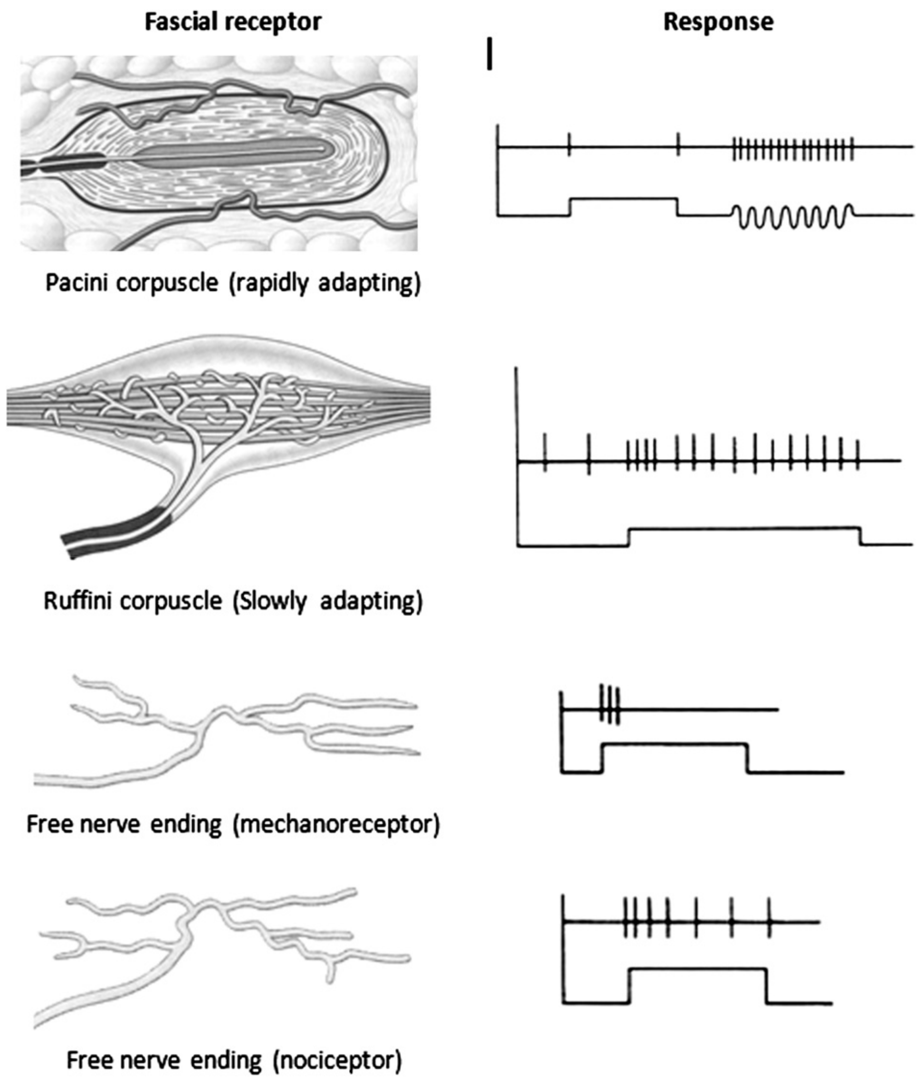

Figure 1 Types of fascial nerve receptors. Modified from Gray's Anatomy, 40th ed. p. 58, Fig. 3.30.

contraction and relaxation, in the short timescales observed in practice (Nekouzadeh et al., 2008; Schleip et al., 2007).

Therapeutic interventions

Manual therapeutic interventions form a broad spectrum of treatments sometimes termed 'bodywork'. The therapies considered here are limited to systems of treatment involving the application of manual force for therapeutic effect (McPartland and Miller, 1999). Whilst this definition covers a very large range of therapies, the techniques included may be condensed down to HVLA adjustments, mobilisations, myofascial release techniques of various kinds and massage. However, it excludes interventions such as needling and ultrasound. Additionally, therapies which may be considered as myofascial in nature but use movement as the primary modality (Cantu and Grodin, 2001), such as Feldenkrais, are likewise not considered here. It should be borne in mind that the emphasis here is on the technique and not the system, for example whilst HVLA techniques are generally associated with chiropractors and osteopaths, those systems include other techniques and are not limited to HVLA treatments.

For convenience of analysis, the therapies considered have been divided into groups of manipulative techniques and myofascial techniques as previously defined. The reasons for this are that, viewed from a biomechanical standpoint the myofascial techniques are relatively slow in action and nominally affect 'static' tissue between joints whilst the manipulative therapies are generally delivered quickly and are nominally aimed at mobile tissues around the joint. This division is identical to that used by others (Bialosky et al., 2009; Korr, 1977).

Within the analysis of each group of therapies, consideration is given to hypothesised mechanical and neurophysiological explanations for the results of therapies. This paper does not attempt a comprehensive review or comparison of these explanations but uses representative examples from the literature to illustrate the points being made.

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Comparative measures

In order to make a comparison possible, the therapeutic benefits and effects of passive manual therapies are considered, from the point of view of a patient. In order to gauge these effects the patient-centred measures of pain, function and what is termed here as 'autonomic activation' were chosen as they appear to be common to a large number of therapies.

The first two measures (pain and function) are both straightforward and self-explanatory, and indeed are the primary reasons for using manual therapies (Threlkeld, 1992).

The latter measure (autonomic activation) is multifaceted and probably cannot be quantified as a single entity. In reported trials it is not often assessed, probably because it is regarded as a side-effect rather than as a principal benefit. Manual therapies are used primarily to treat pain, and pain is linked to both somatic and autonomic changes (Lewit, 2010). Examples of measures of autonomic activation are heart rate variability (HRV) or 'vagal tone', blood pressure and skin conductance. Salivary cortisol has also been used as a measure of stress which is linked to autonomic activation. The justification for its use here is that, in cases where some attempt has been made to assess it, the evidence shows that it appears to be closely associated with the manual techniques examined, both manipulative (Eingorn and Muhs, 1999) and myofascial (for example Holey, 2000). It is of note that the autonomic effects of therapies may not just be local to the area worked but much more widespread.

Evidence is given in Tables 2 and 3 for the autonomic effects of, respectively, selected manipulative and soft tissue therapies. Although there is a well known association between spinal manipulative therapy (SMT) and autonomic effects (for example Boyling and Jull, 2004) there do not appear to have been many clinical trials demonstrating this. Similarly the number of trials reporting autonomic effects with myofascial therapies is also very limited. As with the discussion on theories for the mechanisms of manual therapies, this paper is not intended to be a comprehensive review of the trial-based evidence and the references used are those which appear to typify the therapy concerned.

Manipulative therapies

This group of techniques are often thought of, and indeed often justified, through the effect of joint manipulation upon associated musculature and soft tissues (Boyling and Jull, 2004). The techniques considered here, commonly used by chiropractors, osteopaths and manipulative physiotherapists, are SMT i.e. HVLA adjustments and mobilisations including those devised by Mulligan (2004). The terms 'manipulation' and 'mobilisation' have been used interchangeably elsewhere. In this paper, mobilisation has the meaning given by Maitland (Farrell and Jensen, 1992) as passive movement of a joint within the physiological range capable of being prevented by a patient, and manipulation has the characteristics given by Evans and Lucas (2010) which includes cavitation.

Much has been written about the possible mechanisms involved in manipulative therapies, and in particular SMT. The descriptions of possible mechanisms, below, are not exhaustive and the discussion is intended to focus on the possible role of fascia.

Mechanical mechanism

Joints are designed to be naturally mobile, so that a joint restriction needs to have an origin. McPartland and Simons (2006) for example have observed an association between myofascial trigger points (MFTrP) and nearby articular dysfunction and state that the joint hypomobility is mainly due to soft tissue restriction helped by a positive feedback loop via the central nervous system (CNS). Lewit (2010) also notes the presence of altered muscular tone with joint restrictions and this may help to explain the success of techniques such as post-isometric relaxation (PIR) and

Table 2 Autonomic effects of some manipulative therapies.

Therapy	*N*	Population/study type	Authors	Outcome measures	Results
SMT	28	Controlled cross-over trial comparing sham and thoracic SMT.	Budgell and Polus (2006)	Heart rate variability	HVLA appears to influence heart rate variability over and above a sham procedure.
Mobilisation	NA	Systematic review of 15 trials of cervical mobilisation.	Schmid et al. (2008)	Not applicable	Overall study quality (which met criteria) was high. Evidence of hypoalgesia, SNS excitation, changes in motor function.
	45	RCT of healthy males with unilateral PA mobilisation (grade III at 2 Hz) of L4/5.	Perry and Green (2008)	Skin conductance	Statistically significant change to skin conductance on ipsilateral side greater than contralateral side i.e. side specific effect.
NAGs, SNAGs, etc.	16	RCT of healthy subjects	Moulson and Watson (2006)	Skin conductance and skin temperature before and for 2 min after intervention.	Statistically significant changes to skin conductance and temperature in treatment and placebo groups although greater in the treatment group.

Abbreviations: NA, not applicable; RCT, randomised controlled trial; (S)NAG, (sustained) natural apophyseal glide.

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Table 3 Studies showing the effects of various myofascial therapies.

Therapy	*N*	Population/study type	Authors	Outcome measures	Results
Structural integration (SI)	30	Healthy subjects grouped by age (26–41 *n* = 20, 55–68 *n* = 10)	Cottingham et al. (1988a)	Parasympathetic tone as measured by vagal tone.	The younger age group showed statistically significant increased parasympathetic activity during the manoeuvres relative to the older age group.
	32	RCT, healthy subjects, mean age 27 years	Cottingham et al. (1988b)	Pelvic tilt and parasympathetic tone as above	The intervention group showed a statistically significant decrease in the pelvic tilt and increase in the parasympathetic tone which was maintained 24 h afterwards.
	31	Neck pain subjects, 22–66 years visiting SI clinic.	James et al. (2009)	Pain, cervical ROM	Statistically significant differences in pain and objective measures of ROM after 10 sessions of SI.
	18	Subjects with subacute or chronic patellar tendon pain, mean age 29.2 years.	Pedrelli et al. (2009)	Pain	Statistically significant decrease in pain maintained at 1 month.
Trigger point massage therapy	30	RCT with healthy subjects, mean age 32.5 years, using myofascial trigger point massage.	Delaney et al. (2002)	Heart rate variability	Statistically significant decreases in heart rate, systolic and diastolic blood pressure and increase in parasympathetic activity.
Massage	44	Double blinded RCT, healthy subjects, mean age 23.3 years, all with induced DOMS following exercise.	Frey Law et al. (2008)	Pain, mechanical hyperalgesia	Statistically significant decreases in stretch pain and mechanical hyperalgesia following deep tissue massage. Superficial massage only reduced mechanical hyperalgesia but not stretch pain.
	16	Healthy male subjects, mean age 32 years in a cross-over trial.	Aourell et al. (2005)	Systolic and diastolic blood pressure	Statistically significant decreases in systolic initially and subsequently diastolic blood pressure.
	62	RCT with healthy, active subjects, mean age 21.1 years, following high intensity exercise.	Arroyo-Morales et al. (2008)	Heart rate variability and blood pressure	Statistically significant changes to blood pressure and heart rate variability i.e. quicker return to baselines values, compared with sham therapy.
Osteopathic manipulative therapy (OMT)	17	Healthy subjects, 9 males, 8 females aged 19–50 years acting as own controls.	Henley et al. (2008)	Heart rate variability	In this instance OMT was taken to mean myofascial as discussed in the main text. OMT was able to overcome the sympathetic tone with an increased level of parasympathetic activity when subjects were tilted.

Abbreviations: RCT, randomised controlled trial; ROM, range of motion; MBT, myofascial band therapy; DOMS, delayed onset muscle soreness.

reciprocal inhibition (RI). Autonomic phenomena have been associated with MFTrPs (for example Ge et al., 2006; McPartland and Simons, 2006).

Evans (2002) in a review notes that a possible mechanism is (mechanical) disruption of articular or periarticular adhesions. However, little evidence is given to substantiate the nature of the adhesions which may be disrupted.

Neurophysiological mechanism

A widely reported concept to explain both the immediate and sustained effects of these therapies is a neurophysiological mechanism both for joint related therapies (for example Boyling and Jull, 2004; Fryer, 2003; Korr, 1977; Pickar, 2002) and mobilisations (Perry and Green, 2008; Schmid et al., 2008; Vicenzino et al., 2007).

Mobilisation stimulates the same tissues as SMT and these are not just confined to the joint being treated, but also comprise the surrounding musculature and its associated fascial coverings, the deep fascial interconnections and other passive tissues such as ligaments. With manipulative therapies the joint is considered as the primary source of afferent stimulation but this may not necessarily be the case. The number of receptors around a joint is far outweighed by those in the surrounding fascia (such as epimysium and deep fascia) so that absolute joint motion may not play a large component in the response (Cantu and Grodin, 2001). This idea is supported in a study on cats (Pickar and McLain, 1995) where it was found that manipulation of an isolated lumbar facet joint produced responses in type III and type IV fibres at some distance from the joint.

The manner of delivery between SMT and mobilisation differs, with mobilisation having rhythmically applied, smaller movements within a joint's physiological range whereas SMT uses a single impulse of high velocity and low amplitude beyond the physiological joint range often associated with a cavitation (Evans and Lucas, 2010; Pickar, 2002). Bronfort et al. (2004) found that the longer term outcomes (pain, disability) of the two therapies are largely comparable for low back and neck pain and to that extent it may be expected that the mechanisms behind the two therapies are similar. However, in a review of the hypothesised mechanisms of SMT, Evans (2002) suggests that SMT and mobilisation be considered as separate clinical entities. He indicates that the cavitation associated with SMT produces additional physiological effects not directly achieved by mobilisation but the reviewed studies looked at the immediate short term effects of the therapy and did not consider longer term consequences.

Korr (1977) noted individuals with "musculoskeletal strain", trauma and tenderness had segmental patterns of altered sympathetic activity. These patterns were highly variable between individuals but they were also stable and reproducible over several months. This is in agreement with the review by Budgell (2000) who found a link between noxious stimulation of spinal tissues and segmentally organised autonomic responses. Budgell also considered "innocuous" stimuli but failed to observe a link. Both of these studies are consistent with Pickar (2002), who suggests that for autonomic responses there is a differentiation between noxious and non-noxious stimuli in the spine, with the former exciting sympathetic responses and the latter having an inhibitory effect. As noted previously, fascia contains group III and IV fibres, each of which has 2 subgroups with low and high levels of mechanosensitivity and the parallel between the two is interesting.

Myofascial therapies

This group covers a much more numerous and varied spectrum of techniques, including osteopathic soft-tissue techniques, structural integration (Rolfing), massage including connective tissue massage (CTM), instrument assisted fascial release e.g. Graston™ technique, trigger point release, strain–counterstrain and the muscle energy technique (MET) family, of which PIR is an example.

At this point it is worth noting that charge-based mechanisms may explain the effects of myofascial therapy. Barnes (1997) discusses piezoelectric effects related to collagen and Oschman (2009 for example) discusses charge transfer in relation to therapeutic interventions for acute or chronic injuries and inflammation. However, Langevin (2006) notes that the evidence is limited and it is unknown whether fascia actually transmits signals *in vivo* and if so whether they are significant. This potential mechanism is not considered further.

Mechanical mechanism

Mechanically based therapies rely on the direct effects of stress or stretch through pressure and perhaps also heat and friction to achieve their effects. Techniques such as Graston™ may apparently rely only on the mechanics of fascia but aspects of other therapies may also fit into this category such as the deep tissue work with structural integration. All therapies aim to break up adhesions and speed up a return to normal function.

The intended outcome is a permanent alteration to the tissue structure and this may occur through collagen fibres sliding past each other (slowly) in response to stretch, a phenomenon known as creep, a loosening of the cross-links between the collagen fibres or the desired outcome may be microfailure of the collagen fibrils (Threlkeld, 1992) as their tensile strength is exceeded. Either way, the character of the tissue is changed and is softened. When microfailure of collagen is induced through instrument assisted fascia release (e.g. Graston™) there is deliberate damage and the release of inflammatory mediators in an attempt to speed healing.

Neurophysiological mechanism

Neurophysiological explanations have also been forthcoming for myofascial therapies including massage, myofascial release, CTM, structural integration and trigger point therapy (despite their uncertain pathogenesis). As noted earlier, mechanical explanations alone do not appear to be sufficient to explain palpable tissue change occurs in short timescales. The relatively low level of forces used by manual therapists is insufficient to cause microfailure of the collagen (Barnes, 1997; Chaudhry et al., 2008) except perhaps in very thin or loose tissue such as the nasal fascia. Thus it is likely that a large part of the benefits of myofascial therapies are due to neurophysiological effects (Cantu and Grodin, 2001; Schleip, 2003a).

CTM uses fascial treatments to address neurological, musculoskeletal and visceral complaints many of which have an autonomic component. Much has been written on the origin of visceral pain and its relation to somatic pain, briefly reviewed by Giamberardino and Vecchiet (1997). There is a well documented convergence between visceral and somatic afferents onto the same second order neurons ('convergence-projection'), although this mechanism is not sufficient to explain all observed phenomena (Vecchiet et al., 1999). Holey and Cook (2003) relate this to Korr's 'facilitated segment'. This reinforces the impression of a strong link between fascia and the autonomic nervous system (ANS).

With MET the mechanism is not yet understood. Ballantyne et al. (2003) report that there is no change in tissue length during PIR and as a result consider the true mechanism to be neurophysiological. Smith and Fryer (2008) also suggest that the mechanism may be neurophysiological but additionally involves mechanical and plastic deformation of the local fascia. Hinz and Gabbiani (2003) report that force production by myofibroblasts responds to the action of cytokines, components of the extracellular matrix and mechanical tension, so the action of muscles and perhaps metabolic products may influence them. Also, increased stimulation of C fibres via stretch receptors in the epimysium may cause a CNS mediated reflex reducing the gain of the γ innervated muscle spindles (Korr, 1975) so reducing the degree of (chronic) muscle tonus.

Schleip (2003b) proposed a model of the dynamics of fascial plasticity when utilising soft tissue 'manipulation', by relating the CNS, ANS and the anatomy of fascia. He considers that the relaxation experienced during therapy is a neurophysiological one.

Non-neurological mechanisms

A brief comment must be made about the potential influence of non-neurological mechanisms which may be activated with manual therapies.

The consistency of the ground substance is regulated by fibrocytes as noted already. Manual therapy is known to alter the tissue tonus and also to change the consistency of the ground substance, and therefore likely to affect the mechanical properties of fascia by altering its viscoelastic, shock-absorbing and energy-absorbing properties (Barnes, 1997).

Another is perhaps through paracrine or endocrine pathways such as the cannabinoid system, which has a widespread regulating role, affecting myofascial tissues including fibroblast remodelling (McPartland, 2008). Cannabinoids have an important CNS role (perhaps related to mood changes) and are also linked to cardiovascular changes and smooth muscle relaxation (Ralevic et al., 2002), effects which have been linked with manual therapies. Osteopathic manipulations have been shown to alter blood serum levels of cannabinoids (McPartland et al., 2005) but further consideration is beyond the scope of this text.

Discussion

So, where is the common ground between myofascial and manipulative techniques?

Reduction of pain and improvement of function are the primary reasons for the use of manual therapies and this occurs for both groups of therapies (for example Bronfort et al., 2010; James et al., 2009). Yet the techniques employed, *prima facie*, appear very different; certainly methods of assessment and diagnosis differ significantly between systems and professions. A recent model of the proposed mechanisms behind manual therapy (Bialosky et al., 2009) is based upon neurophysiology but does not relate the mechanical stimulus to the anatomy, rather it appears to assume that all mechanical stimuli have a similar effect and pathway. However, the concept that there is a common underlying mechanism is similar to the idea in this paper although here we consider specifically the ANS and its relationship to fascia together with clinical outcomes. Manipulative therapies are seen to stimulate fascial tissues in addition to their target i.e. the joint capsule and myofascial therapies are deliberately aimed at stimulating fascial tissues. Figure 2 illustrates this idea. There is clearly a great deal of overlap between the two groups of therapies.

The ANS is involved with many soft tissue therapies (for example Schleip, 2003a) but manipulative therapies also have autonomic involvement (for example Eingorn and Muhs, 1999). Of particular interest is the link between autonomic activity, dermatomal distributions and segmental dysfunction for therapies such as CTM and SMT. A number of authors have stated that the dorsal peri-aqueductal grey (dPAG) is a common link in the chain between afferent stimulation and efferent output including autonomic change (for example Schmid et al., 2008; Sterling et al., 2001; Thomson et al., 2009). The dPAG is a structure known to be implicated in homeostatic (autonomic) regulation and descending inhibition (for example Baldry et al., 2001). In an experiment with cervical mobilisation, Sterling et al. (2001) suggest that the mobilisation may selectively stimulate a specific descending inhibitory pain pathway. It is thus possible that the output of the dPAG may be directional in nature and not just a generalised inhibition of pain and stimulation of the sympathetic nervous system. Therefore the stimulation delivered to the CNS by therapeutic interventions is likewise not just generalised but has a directional quality i.e. the origin of the stimulation is important. Observing the differing orientations of fascial planes in the body, the differing types of mechanoreceptors which can be stimulated, and the variables involved in the application of therapies this may be a valid conclusion. However, Langevin (2006) notes that very little is known about the spatial integration of afferent signals from the fascia.

A brief discussion of the potential role of the mechanoreceptors in fascia is appropriate here. Pacini corpuscles respond to fast stimulation but not to steady pressure, whereas Ruffini corpuscles respond to slow steady stretch. Schleip (2003a) speculates that the former might be influenced more by HVLA and "vibratory" techniques (c.f. mobilisation) and the latter by "slow and deep" myofascial techniques. It is tempting to stop there, but the situation is complicated by the presence of nociceptors within fascia as noted already, of which types III and IV have 2 set of receptors responding to low and high levels of stimulation. It is possible that both HVLA and "slow and

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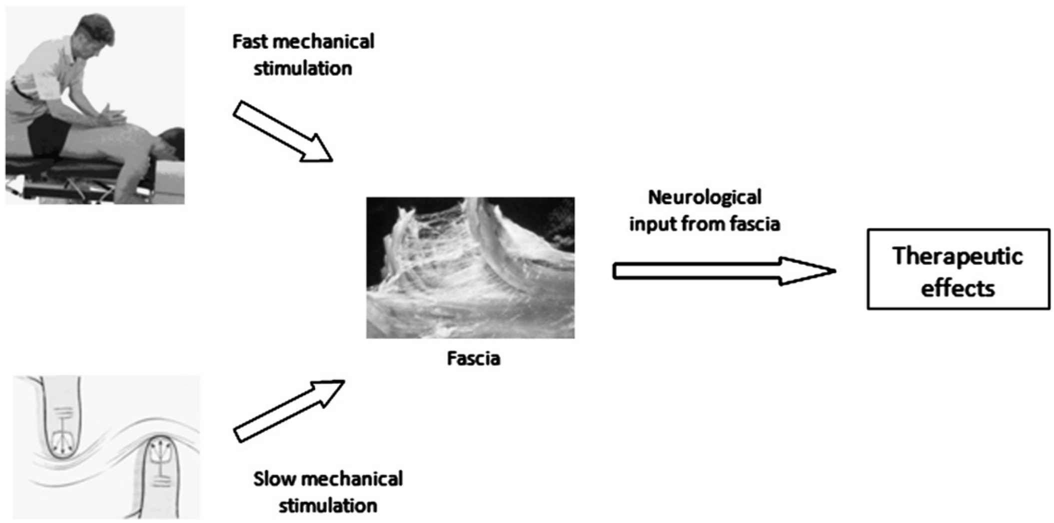

Figure 2 Flow chart diagram of common paths of therapeutic stimulation of fascia. Modified from: Byfield, D. 2005. Chiropractic Manipulative Skills, second ed., p. 327, Fig. 11.30a; Myers, T. 2009. Anatomy Trains, second ed., p. 4, Fig. 6; Chaitow, L., DeLany, J., 2002. Clinical Application of Neuromuscular Techniques, vol. 2, first ed., p. 276, Fig. 10.43.

deep" techniques stimulates both levels of nociception whereas massage for example may only affect the low level nociceptors. Further considerations are beyond the scope of this paper as its main aim is to draw out similarities in the outcomes used at a high level than to go into too much detail about the mechanisms.

Tables 2 and 3 present a range of studies linking, respectively, manipulative and myofascial therapies to autonomic activation. The main limitations are that all measured the short term after-effects of an intervention whereas the longer term effects were not considered, and in addition all were performed on healthy subjects. Although the data is very limited, the most consistently assessed measure of autonomic output in these studies is HRV. In a study with SMT, Budgell and Polus (2006) found that SMT to the thoracic region shifted the autonomic output to the heart in favour of the sympathetic component and away from the parasympathetic. Delaney et al. (2002) used trigger point massage (to the trapezius, sternocleidomastoid, frontalis and temporalis muscles) and found an increase in the parasympathetic output to the heart. Cottingham et al. (1988a) assessed 2 different age groups of male patients (mean ages 32 and 63 years) with a 'pelvic lift' procedure used in Rolfing, and found that the procedure increased the parasympathetic component in the younger age group but not in the older. Henley et al. (2008) studied the effect on HRV of osteopathic manipulative treatment (OMT). The use of the word manipulative in OMT is presumed not to mean an HVLA adjustment. They found that 'cervical myofascial release' increased the parasympathetic component, although no details of the actual procedure are given, but to the extent it was applied to the neck it agrees with the findings of Delaney et al. (2002). The study on massage by Arroyo-Morales et al. (2008) was applied to subjects immediately after exercise, and although an increased parasympathetic output was observed the authors also comment that it could not be ruled out that the effects were due, at least in part, to the increased respiratory effect with exercise. Of the studies mentioned here, only the SMT produced an increase in the sympathetic tone, whereas all the others produced increases in the parasympathetic tone. However, the SMT study, apart from the obvious difference in technique was applied to the thoracic area and others techniques were applied to the head, neck, shoulders and pelvis. Unfortunately the data is too sparse to draw any reliable conclusions.

It is proposed that the basis for the neurophysiological mechanisms of myofascial therapy and manipulative therapy are one and the same. It may be considered that these 2 broad categories of therapies are at two ends of a continuous spectrum of effects, and the place in that spectrum is dependent on the manner of delivery, not of mechanism. Indeed, the only differences in therapies seem to be essentially between methods of afferent stimulation e.g. via slow or fast stretch and also perhaps the types of mechanoreceptor stimulated. Korr (1977) considered neurophysiological mechanisms in manual therapies and initially divided them into 'impulse' and 'non-impulse' groups. However he was unable to draw a clear distinction between them, stating "If barriers existed, they were in minds and methods, not in the biological system...". The ideas here agree with that conclusion.

Fascia (as generalised connective tissue including its muscular wrappings as epi- and peri-mysium) is a biologically plausible source of nociception and mechanoreception which is common to all manual therapies. Both myofascial and manipulative therapies stimulate fascia in its various forms at varying tissue depths. As soon as any pressure is exerted on the skin, mechanoreceptors in the various layers will start to fire, initiating the complex physiological and neurological responses both locally and systemically. Thus it is possible that at a low level of pressure such as in massage, the patient may not register the sensation as the stimulus activates the low level group III and IV mechanoreceptors, yet local and systemic changes occur through neurological afferent input and perhaps other mechanisms (see below). Stronger stimuli such as a HVLA manipulation or deep fascial work may activate the high level mechanoreceptors leading to further afferent CNS stimulation.

The pioneering model of the neurophysiology of fascial plasticity proposed by Schleip (2003b) was intended for soft tissue therapies. However it can be readily appreciated that this model may also be extended to manipulative therapies as well. Whilst Schleip considers the CNS and ANS as having separate 'loops' in the feedback pathway, it is more likely that they are linked, probably by the dPAG. This would enable the body to have a coordinated response to a stimulus. Schleip's model may need to be adapted further.

Consider the following thought experiment: a patient is measured for pain, function and autonomic state. He then goes into a separate room where an unknown style of treatment is applied. Upon exiting the room the same variables are measured. Given the information already presented on manual therapies it is proposed that it would be difficult to deduce from the measurements alone, which style of treatment had been applied. It may thus be considered that techniques normally thought of as being unrelated may be akin to one another. The idea may go some way to explaining why the longer term results from different therapies are equivalent.

Conclusion

This paper reviews the literature on the effects of manual therapies and, briefly, on the anatomy of fascia. It sets out a theoretical, testable framework which links fascia into the therapeutic benefits provided by what have been traditionally distinct modes of therapy here termed 'manipulative' i.e. HVLA manipulations and mobilisations, and 'myofascial' i.e. slower working of soft tissues. The authors' view is that seen from the beneficial end point of therapies i.e. improvement in patients' health, no real distinction exists between these 2 classes of therapies. They may be viewed as points on a continuous spectrum of therapeutic benefit, due in a major part to the stimulating effects of these therapies upon fascia.

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