Journal of Bodywork & Movement Therapies (2010) **14**, 318—325

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FASCIA RESEARCH

How much time is required to modify a fascial fibrosis?

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Received 9 October 2009; received in revised form 18 January 2010; accepted 10 April 2010

KEYWORDS
Connective tissue;
Fascia;
Manipulation;
Plasticity;
Low back pain;
Manual therapy

Summary The perception of what appears to be connective tissue fibrosis, and its consequent modification during therapy, is a daily experience for most manual therapists. The aim of this study was to evaluate the time required to modify a palpatory sensation of fibrosis of the fascia in correlation with changes in levels of patient discomfort in 40 subjects with low back pain utilizing the Fascial Manipulation technique. This study evidenced, for the first time, that the time required to modify an apparent fascial density differs in accordance with differences in characteristics of the subjects and of the symptoms. In particular, the mean time to halve the pain was 3.24 min; however, in those subjects with symptoms present from less than 3 months (sub-acute) the mean time was lesser (2.58 min) with respect to the chronic patients (3.29 min). Statistically relevant ($p < 0.05$) differences were also evidenced between the specific points treated.

Introduction

Many authors (Myers, 2001; Schleip, 2003; Stecco, 2004; Hammer, 2007; Chaitow, 2008; Masi and Hannon, 2008) suggest that trauma or overuse syndromes can alter the connective tissue and that, in particular, it could become tighter, altering its histological, physiological and biomechanical characteristics. The process that induces pathological modification of myofascial tissue is still not clear. Some authors (De Deyne et al., 2000; Matsumoto et al., 2002) suggest it could be due to an alteration of the collagen fibre composition. Others (Schleip et al., 2005, 2006; Chiquet et al., 2007; Grinnell, 2008) evidence the

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doi:10.1016/j.jbmt.2010.04.006

alteration of the fibroblasts with their transformation into myofibroblasts, while others (Whatmore and Kholi, 1974; Staubesand and Fischer, 1980; Scott, 2003; Hammer, 2007; Stecco and Stecco, 2009) suggest an alteration in the ground substance due to neurophysiological influences and changes in biochemical fluid relationships could be involved. There is some agreement that when fascia loses its pliability and becomes restricted, it could be a source of body misalignment and that, over time, this can potentially lead to poor muscular biomechanics (Barker et al., 2006), altered structural alignment, and decreased strength and motor coordination (Stecco, 2004; Fourie, 2008). Subsequently, patients may experience pain and functional deficit.

It is also theorized that different manual and physical techniques could restore the normal physiological state of the fascia, but there is very little scientific evidence about the mode of action of manual therapies in general. The Cyriax method (1980) of deep transverse massage and similar manual therapies, such as the Graston Technique (Hammer, 2003, 2004) and Rolf (1963), propose modification of connective tissue mobility using the force of cross fibre friction. According to the Myofascial Release technique (Barnes, 1990), a sustained pressure applied into a restricted tissue barrier will cause this tissue to undergo histological length changes, and after 90—120 s, a sensation of perceivable release is noted and the tissue softens and becomes more pliable. Other authors claim that restoration of length and health to the myofascial tissue could relieve pressure on pain sensitive structures such as nerves (Sucher, 1993) and blood vessels (Queré et al., 2009), as well as restoring alignment and mobility to the joints (Day et al., 2009). The Fascial Manipulation technique (Stecco, 2004; Stecco and Stecco, 2009) proposes to restore impeded gliding of collagen and elastic fibres within the ground substance by exploiting heat generated from the friction of deep manipulation. According to the law of Van t'Hoff (Haynie, 2001), which describes the relationship between temperature and the velocity of chemical reactions, this process could be established only if friction is applied where rigidity of the fascial tissue is perceived. By applying localized friction in an area of palpable rigidity, the therapist creates local heat and this may increase certain chemical reactions such as the attenuation of the secretion of inflammatory cytokines (Standley and Meltzer, 2008). When connective tissue is heated, it stretches more easily (Lehmann et al., 1970). However, no definitive explanation for the biomechanical bases of these transformations exists.

While manual therapists often report perceptions of altered segmental tissue texture and its modification during therapy (Evanko, 2009), and correlations between changes in pain thresholds and perceived changes in tissue consistencies are at the basis of different therapies (Cyriax, 1980; Typaldos, 2002; Chaitow, 2003; Hammer, 2007; Stecco and Stecco, 2009) little direct evidence for these correlations exists (Fryer et al., 2004). Furthermore, a calculation of the mean time required for such changes to occur and the correlation between different patient subgroups with different degrees of altered fascial tissue is still lacking. De Bruijn (1984) described the application of deep transverse massage to soft tissue pain in 13 subjects. The time required to produce a pain relief during application of this massage varied from 0.4 to 5.1 min, with a mean time of 2 min. Carreck (1994) evaluated the effect of a light stroking massage, applied for a total of 15 min in 20 healthy subjects, and demonstrated that this manoeuvre increased pain threshold levels, elicited by transcutaneous electrical stimulation. Kelly (1945, 1946) applied deep transverse massage for 5 min in 46 volunteers using a minimal amount of pressure that did not cause any pain and demonstrated that this particular modality did not produce a significant modification in the pain perception.

The aim of this study is to evaluate the time required to modify the palpatory sensation of fibrosis of the fascia in correlation with changes in levels of patient discomfort in 40 subjects with low back pain utilizing the Fascial Manipulation technique. We selected low back pain because it is a leading cause of disability with a significant economic impact, not only on lost productivity but also on healthcare expenditures, approximately a fifth of patients will see multiple physicians in their quest for relief of low back pain (Jerymyn, 2001) and most manual therapies present specific treatment of this pathology. Furthermore, the fascial planes of the thoracolumbar fascia have been hypothesised to play a role in the pathogenesis of low back pain (LBP) (Langevin and Sherman, 2007; Schleip et al., 2007) and there is some initial evidence of correlations between altered connective tissue structures and LBP (Langevin et al., 2009), as well as preliminary studies indicating possible differences in motion between fascial layers in the thoracolumbar fascia in subjects with LBP as compared to a no-LBP groups (Fox et al., 2009).

Three small areas over the thoracolumbar fascia that, according to Fascial Manipulation theory (Stecco and Stecco, 2009), are primarily involved in LBP mechanisms have been selected for treatment:

- The area located at the level of the first lumbar vertebra, approximately 3 cm laterally to the spinous process of L1 for the paravertebral muscles. Note: in Table 1 this point is indicated with the abbreviation re-lu (retro-lumbi), which is an abbreviation used in the Fascial Manipulation technique to indicate this specific area (Stecco, 2004).
- The area located at the level of the third lumbar vertebra at approximately 5 cm laterally to the spinous process of L3 for the quadratus lomborum. Note: this point is indicated with the abbreviation la-lu (latero-lumbi).
- The area immediately below the twelfth rib is for the latissimus dorsi, posterior inferior serrati and external oblique muscles. Note: this point is indicated with the abbreviation er-lu (extra-lumbi).

Materials and method

Three operators (B.E., S.A., D.J.A.), each one with more than five years of experience in this method, analysed the time required to reduce the pain provoked during the application of this technique by half. Prior to this study, the 3 operators evaluated the three points considered for this study in 10 patients with low back pain and compared

Table 1 The main characteristics of the treated subjects and the initial and final pain, evaluated with the Verbal Numeric Scale, are reported.

				Right side				*Left side*			
Gen	*age*	*Chron.*	*point*	*Initial VNS*	*Time to 50% reduction respect to the initial pain (mins.)*		*Final VNS*	*VNS*	*Time to 50% reduction respect to the initial pain (mins.)*		*VNS*
					Sudden decrease	*Slow decrease*			*Sudden decrease*	*Slow decrease*	
M	26	2m	er-lu	8	4.0		3	7	3.2		3
F	43	5y	re-lu	8		4.0	4	7		5.0	3
F	42	4y	la-lu	8		4.0	4	7	2.3		2
M	49	20y	la-lu	8	4.1		2	8	5.1		2
M	52	8m	re-lu	7	3.3		2	8	3.5		2
F	39	3y	re-lu	9	3.4		3	8	3.1		3
F	56	22y	er-lu	8	2.4		3	7	3.2		4
M	50	5y	la-lu	8		6.0	4	9		7.0	4
F	67	10y	la-lu	8	2.5		3	9	3.5		4
M	31	3m	la-lu	7		3.0	3	8		3.3	3
F	62	7y	la-lu	8		6.0	4	7		5.0	3
F	30	5y	la-lu	9	5.3		3	8	4.0		3
F	15	8m	re-lu	7		3.2	3	9		5.0	3
M	32	10y	er-lu	8		4.1	4	6		2.4	2
F	36	5y	la-lu	7		3.0	3	9		5.0	4
M	51	9y	re-lu	9	3.1		4	8	2.5		4
M	20	1y	la-lu	8		4.0	4	7		5.0	4
F	41	6y	la-lu	8	3.0		3	7	3.0		3
M	20	4y	la-lu	8		4.3	4	6	2.3		2
F	22	7m	re-lu	9		5.0	4	7		3.3	3
M	52	10y	re-lu	9	4.1		4	8		5.0	4
F	50	3y	re-lu	9	4.0		3	9	3.3		2
M	61	8y	la-lu	8		2.3	2	0*			
M	45	2y	re-lu	8		2.3	2	9		2.3	2
F	33	2y	la-lu	8	1.5		4	0*			
M	37	2m	er-lu	9	3.0		3	0*			
F	34	6y	re-lu	8	2.3		3	8		3.0	4
F	39	2y	re-lu	8	2.0		3	7	1.0		4
F	35	3m	la-lu	8		3.0	2	8		2.8	4
F	51	10y	re-lu	9		3.1	4	0*			
F	37	6y	er-lu	8		2.0	4	3		2.5	0
M	24	1y	la-lu	8	2.0		3	8		3.2	4
F	36	3m	re-lu	8	0.5		2	8	1.0		2
M	41	20y	la-lu	9		3.0	3	8		3.3	3
F	23	1y	er-lu	9		1.3	3	9		1.3	3
F	58	3y	re-lu	6		1.0	3	8		3.0	3
M	25	1m	er-lu	0				9		2.0	3
F	57	6m	er-lu	9		2.4	4	9		2.0	3
M	32	10y	re-lu	6	2.0		3	6	1.3		3
F	39	2y	la-lu	7	2.5		2	0*			
17M 23 F	39.1 SD ± 13.5	5.34 y	17 la 15 re 8 er	7.9 SD ± 1.5	2.9 mins.	3.35 mins.	3.2 SD ± 0.7	6.7 SD ± 2.8	2.82 mins	3.63 mins	3.0 SD ± 0.9

[a]These patients were treated only on one side because in the opposite side no fascial alteration was detected during comparative palpation.

fibrosis evaluation after each patient until 95% level of agreement was reached (Bland and Altman, 1986). Forty subjects suffering from acute or chronic mechanical low back pain were selected for this study.

The research was conducted on 17 males and 23 females with ages ranging from 15 to 67 years (mean age 39.1 years old, SD $\pm$ 13.85). All of the subjects were evaluated with radiography and MRI prior to participation in this study in order to satisfy the inclusion/exclusion criteria for the study. Subjects who showed evidence of clinical neurological deficit, disc herniation, lumbar spine canal stenosis, systemic inflammatory disease such as rheumatoid arthritis, or had suffered either direct trauma or surgery to the back were excluded to avoid the possibility that excessive adherence between subcutaneous planes could influence the results of this study.

Symptoms of mechanical low back pain were present for a period ranging from several months (m) to several years (y) and, in general, pain was discontinuous with recurrent exacerbating episodes being common (Table 1).

In order to quantify the time required to halve the pain perceived during the application of this technique, the fasciae of three muscular groups often implicated in low back pain were chosen for treatment. These three groups include the paravertebral muscles, the quadratus lumborum muscles, and the muscles that insert onto the inferior border of the twelfth rib. Within each of these muscle groups, a small area of the fascia of approximately two square centimetres, known as the Centre of Coordination,[1] was identified and evaluated.

According to Fascial Manipulation methodology (Stecco, 2004; Stecco and Stecco, 2009), comparative palpation was then applied to examine all these small areas. This process involves operator skills in palpation and detection of altered fascial tissue, while simultaneously questioning the subject about perceived pain or discomfort. By means of continuous verbal feedback, the patient's perception of pain and the palpatory sensation of fibrosis by the therapist were correlated and the most altered small area among the three evaluated points was selected. Treatment was bilateral in most cases, however, in some subjects, only a unilateral alteration of the fascia was noted. Consequently, in these cases, treatment was applied unilaterally to the altered or fibrotic Centre of Coordination. On each point selected for treatment, the operator exercised the minimal amount of pressure necessary to create friction against the fasciae of the abovementioned muscle groups. According to a previous study (Pedrelli et al., 2009), a mean force of 73.5 N over the CC of re-lu was required to produce a piercing pain sensation; in the CC of la-lu a mean force of 61.9 N and over the CC of er-lu a mean force of 35.8 N. The operators all used pressure applied with the olecranon process and upper part of the ulna to perform the treatments, alternating between right and left elbows according to the side of the body treated. The direction of the therapeutic manoeuvres varies according to the underlying structure: in a longitudinal direction with respect to the muscular fibres of the erector spinae (Fig. 1b); in a transverse direction for the quadratus lumborum (Fig. 1c); and in an oblique direction for the muscles below the 12th rib (Fig. 1a).

All subjects were instructed how to report any experienced pain correctly, and were asked to inform the operator about the progression of pain provoked during treatment utilizing a verbal numeric scale (VNS). The verbal numeric scale (VNS) is a simple scale for the evaluation of pain, quite similar to the VAS (Visual Analogical Scale), with which it has a moderate correlation (Fosnocht et al., 2005). Subjects easily understand the VNS, as they are requested to choose a number from 0 to 10 that represents the level of their pain: zero corresponds to the absence of pain and ten corresponds to the most intense pain imaginable. This scale was chosen for this study because immediate and progressive reporting of pain levels was required and the verbal aspect was more functional than the VAS scale. Subjects were also instructed that they could ask for brief rest periods of a maximum of 10 s during manipulation to avoid extended interruptions that may have influenced results.

A chronometer, which was activated at the beginning of each manipulation, was used to evaluate the time required to halve the pain according to pain levels reported by the subject. Prior to commencing treatment, the subjects were asked to report the exact moment in when either a minimal decrease or an important reduction in pain occurred. Subjects were also encouraged to report pain levels regularly (approximately every 30 s) and to indicate when the pain became less than 50% of the initial pain. All these variations in the pain/time curve were noted and reported in the Table 1.

The time within which the therapist perceived a consistent change in sliding between the tissue layers was also noted.

The mean value of the VNS scale measurements at the beginning and at the end of the treatment was calculated. The analysis of the differences in pain resolution among different subgroup of patients and among the three different evaluated points were compared with nonparamentric tests: Kruskal—Wallis test and Dunn's multiple comparison test and Mann—Whitney test for double comparisons.

Results

At the beginning of treatment, the mean measurement of pain as reported by subjects was 7.9 on the most altered side and 6.7 on the contralateral side, while at the end of treatment it was of 3.2 and 3.0 respectively.

The mean time necessary to reduce the referred level of pain to 50% was 3.24 min ($\pm$SD 1.3), but specific differences could be evidenced among the different patients. In the subjects with sub-acute pathologies ($<$3 months), the mean time to halve the pain ($\pm$SD) is 2.20 min ($\pm$1.1), while in the chronic subjects this time increases (3.29 min $\pm$ 1.3). In a few cases (16%), the reduction in pain occurred slowly ($>$5 min), while in 36%, the reduction occurred more quickly ($<$2.5 min). In 54% of cases the pain diminished

[1] A Centre of Coordination (CC) is a small area on the deep muscular fascia where force exerted by the muscular fibres of a specific region converge. The resultant myofascial forces appear to be transmitted to the surface of the deep fascia via its continuity with the endomysium, perimysium and epimysium. The CC has the role of coordinating the motor units that are located within this region.

progressively (Fig. 2), while in 46% one distinctive phase was noted (Fig. 3), with pain passing in less than 30 s from a high score (8 or 9) to a sensation of mere pressure (approximately 3). No specific correlation between a sudden or a slow reduction in pain was noted in any particular area.

The therapists noted a marked increase in tissue mobility more or less at the same time the patients perceived a reduction in pain.

Differences among the evaluated areas are also evident. In the CC of the fascia of the serratus posterior inferior muscle (er-lu), the mean time is 2.56 min ($\pm$0.9); in the CC of the fascia over the quadratus lumborum muscle (la-lu) the mean time is 3.73 min ($\pm$1.3), and in the CC corresponding to the fascia over the muscular mass of the lumbar erector spinae (re-lu) the mean time is 2.91 min ($\pm$1.1). The mean time to halve the pain is different between the dominant and the opposite side, but this difference is not significant ($p = 0.355$).

The time to halve pain at the 75 percentile is in younger subjects (<25 years old) 3.3 min (SD $\pm$ 1.2 min), in adults (26—55 years) 3.8 min (SD $\pm$ 1.4 min) whereas in older subjects (>55 years) 3.4 min (SD $\pm$ 1.2 min). The statistical analysis with Kruskal—Wallis test does not show significant differences between younger and adult ($p = 0.833$), between adult and older ($p = 0.91$) and between younger and older ($p = 0.767$). Also the mean time to half the pain is not statistically different ($p = 0.123$) between males and females, in particular in males, the mean time to half the pain was 3 min, in the females 2.45 min.

Discussion

This study evidenced, for the first time, that the time required to modify an apparent fascial fibrosis differs in accordance with the site and the differences in characteristics of the subjects and of the symptoms. In particular, the difference in the time to halve the pain level between sub-acute and chronic patients, and the differences between the specific small areas that were treated, was statistically significant ($p = 0.006$).

The therapists noted a marked increase in tissue mobility more or less at the same time the patients perceived a reduction in pain. It is hypothesised that pain reduction and increase in sliding of the tissue layers coincides with a sufficient increase in temperature that permits the transformation of the ground substance from its densified state (gel) to fluid (sol), as discussed in Introduction. It could be that an increased fluidity of the extracellular matrix permits the nerve endings within the fascia to adapt to the pressure exercised by the therapist, resulting in a reduction in perceived pain.

Both the right-sided (re-lu, la-lu, er-lu) and the left-sided area were often (87.5%) palpably altered in the same subject, even though the time for the pain to be halved in

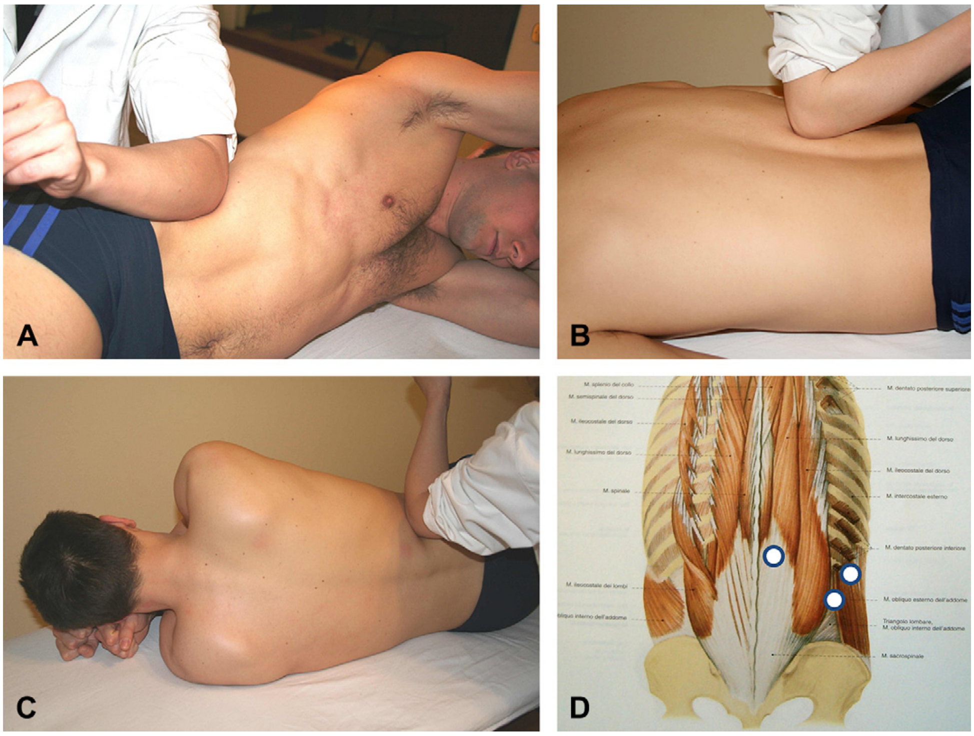

Figure 1 A: Centre of Coordination of ER-LU, localized over the inferior border of the twelfth rib, where the fasciae of latissimus dorsi, posterior inferior serrati and external oblique muscles join together. B: Centre of Coordination of RE-LU, located over the fascia of the paravertebral muscles at the level of the first lumbar vertebra, approximately 3 cm laterally to the spinous process of L1. C: Centre of Coordination of LA-LU, located over the fascia of the quadratus lumborum muscle, at the level of the third lumbar vertebra, approximately 5 cm laterally to the spinous process of L3. D: schematic representation of the localization of the three Centres of Coordination considered in this study.

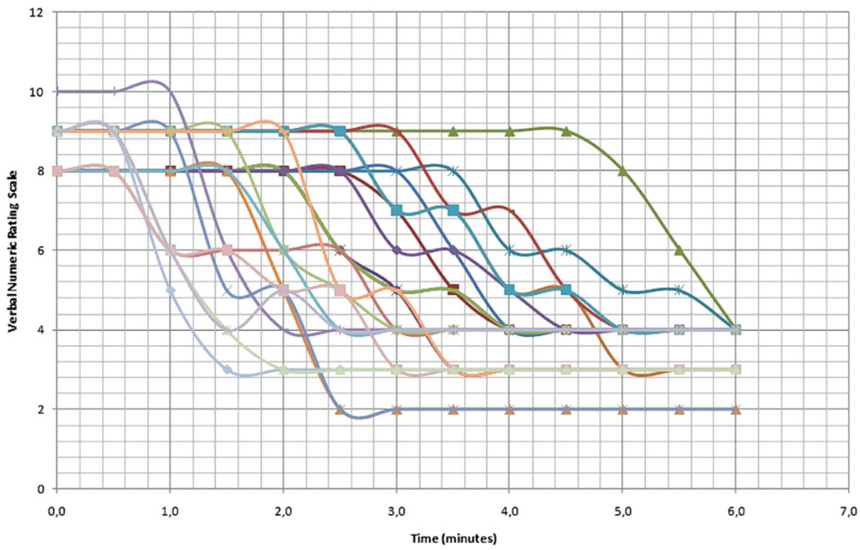

Figure 2 Pain level vs time graph, overlaid for each of the subjects that had a slow decrease of the pain.

the two areas was not always the same. While this difference is not statistically significant ($p = 0.355$) it could nevertheless signify that the fasciae, on the two sides of the body, may not always be altered in the same manner. These differences could cause postural imbalances, determining involvement of different muscle groups. Tensional anomalies caused by fascial alterations do not usually cause pain within the muscular fascia itself but could alter joint movements, causing pain at this level. Pain associated with mechanical low back dysfunction is often felt in the lumbosacral region, which is an important pivot zone for the lumbar muscles, however, according to the biomechanical model adopted in Fascial Manipulation, the areas of the fascia that require treatment are generally located at a distance from the site of pain.

There are not statistically significant differences in the duration of the treatment between young, adult and old patients and between males and females.

Different studies have highlighted the atrophy of paraspinal, quadratus lumborum, psoas and, most prominently, multifidus muscles in chronic low back pain (Kamaz et al., 2007; Hides et al., 2008a,b), although the paraspinal component is arguable (Kalichman et al., 2009). Other studies show evidence of atrophy of multifidus in chronic neck pain (Fernández-de-las-Peñas et al., 2008) as well as a reduced capacity to perform voluntary isometric contractions in some of these muscles (Wallwork et al., 2009). This does appear to be a localized phenomenon and asymmetry between sides in chronic LBP patients presenting with a unilateral pain distribution has been evidenced (Hides

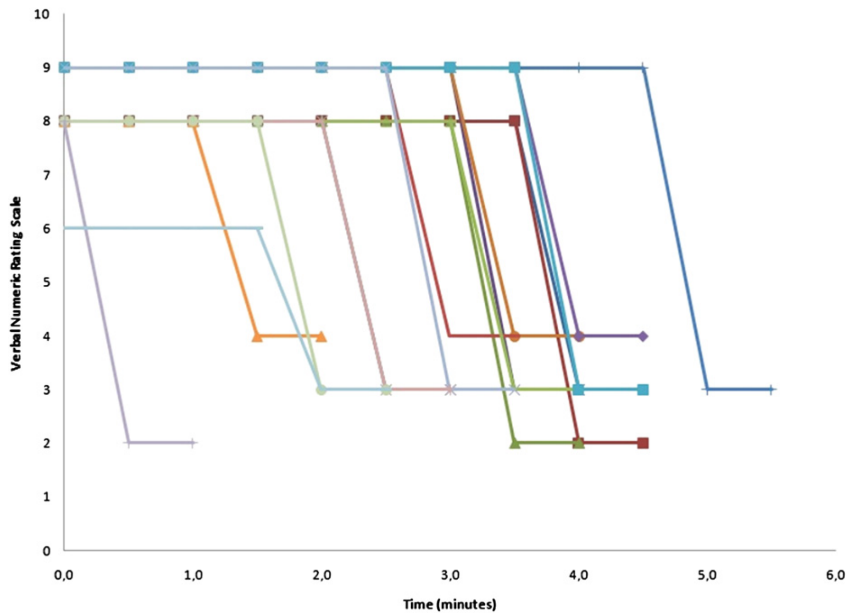

Figure 3 Pain level vs time graph, overlaid for each of the subjects that had a sudden decrease of the pain.

et al., 2008a,b). Therefore, it is probable that on palpation the muscular structure of these sub-groups is very different. While motor control impairment is an important aspect in chronic low back pain, this study has focused on the overlying fascia, and its response to localized pressure. Apart from Langevin et al.'s study (2009), which focused on an area 2 cm lateral to the midpoint of the L2-3 interspinous ligament, in literature, specific studies analysing eventual variations of the fasciae, for example in thickness or resistance, among different groups and subgroups are still lacking.

Our present study highlighted the differences in time as indicated by Cyriax (Stasinopoulos and Johnson, 2004) for the mobilisation of tendons (about 15 min), as compared to the time required to halve the pain and to apparently produce a palpable difference in the connective tissue by acting specifically on altered fascia (3 min). According to the Fascial Manipulation technique (Stecco, 2004; Stecco and Stecco, 2009), a tendinous irritation or inflammation is often a consequence of poorly coordinated muscle fibre recruitment, and emphasis is given to identifying small areas of altered fascia as the possible cause. In general, a connective tissue alteration is not an isolated phenomenon but distributes along muscle chains or myofascial sequences. Therefore, where necessary, it is important to act along the different points of a dysfunctional chain in the same treatment session. If therapists are able to re-create a global balancing of connective tissue mobility, then it is possible to have interesting results with a single session of Fascial Manipulation.

Certainly, the perceived pain that is experienced at the beginning of the treatment is a relatively negative aspect and clinical research exploring less painful alternatives is encouraged. Nevertheless, rapid and effective resolution of chronic low back pain is advantageous. All subjects were advised about procedure prior to commencement and were active participants during all phases of treatment. In our experience, when the technique is applied appropriately, exercising a focused pressure and respecting the individual levels of pain tolerance and general health condition, the benefits from this type of treatment often outweigh the disadvantages of the discomfort experienced.

The role of psychological distress in these patients was not evaluated. Further studies are necessary to evaluate if an alteration in central nervous system processing (such as somatisation, anxiety, depression), often evident particularly in chronic pain groups, may have had bearing on the outcomes.

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