Ultrasonography in myofascial neck pain: Randomized clinical trial for diagnosis and follow-up

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ORIGINAL ARTICLE

Ultrasonography in myofascial neck pain: randomized clinical trial for diagnosis and follow-up

Antonio Stecco · Andrea Meneghini · Robert Stern · Carla Stecco · Marta Imamura

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Abstract
Objective A definitive diagnosis of chronic neck pain (CNP) is sometimes not possible. The aim of this study was to understand the possible role of the deep fasciae in CNP and the utility of the ultrasonography in the diagnosis of myofascial neck pain.
Methods The morphometric and clinical data of 25 healthy subjects and 28 patients with CNP were compared. For all subjects, the active and passive cervical range of motion (ROM) was analyzed and the neck pain disability questionnaire (NDPQ) was administered. The fascial thickness of the sternal ending of the sternocleidomastoid and medial scalene muscles was also analyzed by ultrasonography.
Results There were significant differences between healthy subjects and patients with CNP in the thickness of the upper side of the sternocleidomastoid fascia and the lower and upper sides of the right scalene fascia both at the end of treatment as during follow-up. A significant decrease in pain and thickness of the fasciae were found. Analysis of the thickness of the sub-layers showed a significant decrease in loose connective tissue, both at the end of treatment and during follow-up.
Conclusions The data support the hypothesis that the loose connective tissue inside the fasciae may plays a significant role in the pathogenesis of CNP. In particular, the value of 0.15 cm of the SCM fascia was considered as a cut-off value which allows the clinician to make a diagnosis of myofascial disease in a subject with CNP. The variation of thickness of the fascia correlated with the increase in quantity of the loose connective tissue but not with dense connective tissue.

Keywords Fascia · Myofascial pain · Ultrasonography · Neck pain

Abbreviations

ROM	Range of motion
SCM	Sternocleidomastoid muscle
CC	Center of coordination
HA	Hyaluronic acid, hyaluronan
NPDQ	Neck Pain Disability Questionnaire
LCT	Loose connective tissue
MRI	Magnetic resonance imaging
VAS	Visual analogical scale
MEL	Massage electrotherapy Laser
FM	Fascial manipulation

Introduction

Chronic neck pain (CNP) is a very prevalent condition, affecting 10–24 % of the population [5]: 30–50 % of adults

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present with neck pain in the course of a year [24], and 11–14 % have loss of work productivity due to neck pain every year [10]. The economic costs of this condition are estimated at hundreds of millions of dollars [5]. However, a definitive diagnosis of its causes is often not possible in the clinical setting [4]. Jensen [18] examined the clinical reality that patients presenting with neck pain may have several concurrent sources of pain, from joints, muscles and ligaments. However, as the specific origin of neck pain sometimes cannot be identified, the terms *non-specific neck pain* and *myofascial pain* are often used, although these diagnoses are made for purposes of exclusion and are based only on clinical determinants [15]. There are in fact very few studies which describe objective and clinically applicable methods for identifying and classifying myofascial pain: Shultz et al. [32] quantified the most painful regions with electrodermal instruments, and Arokoski et al. [1] demonstrated increasing superficial soft tissue stiffness. Thermographic studies in areas reported to be painful provide variable results [16].

There is great interest regarding the role of ecography in the diagnosis of myofascial pain. Sonography is a readily available, portable, and inexpensive imaging modality, suitable for use in a physiatrist's office to complement physical examination and to evaluate treatment outcomes. There are some studies regarding the use of sonography or magnetic resonance imaging (MRI) scans to support the diagnosis of plantar fasciitis [28]. These demonstrate that thickening of the fascia is a well-established criterion for diagnosing the syndrome. Langevin et al. [21] recently found significant correlations in male subjects with chronic low back pain between thoracolumbar fascia shear strain and the following variables: perimuscular connective tissue thickness ($r = -0.45$, $P < 0.001$), echogenicity ($r = -0.28$, $P < 0.05$), trunk flexion range of motion (ROM) ($r = 0.36$, $P < 0.01$) and trunk extension ROM ($r = 0.41$, $P < 0.01$), thus demonstrating the importance of ultrasonography in evaluating alterations of the thoracolumbar fascia in low back pain.

The aim of this study was to quantify the thickness of the deep fasciae of the neck and their sub-layers, by means of ultrasound imaging with and without CNP. This will help to document ultrasound as a suitable instrument for diagnosing myofascial neck pain.

Methods

Pre-clinical study

A pre-clinical study was performed to collect control data from normal subjects. Twenty-five Caucasian subjects without history of neck pain (10 M, 15 F, range 29–51 years, mean age 38.9 years) were recruited, and the passive and active ROM of the neck was evaluated. We then performed an ultrasonographic study to measure the thickness of the deep fasciae and the muscle belly of the sternocleidomastoid (SCM) and scalene medius muscles bilaterally. An Aloka Prosound machine, with 38-mm linear array transductors, 5–10 MHz, was used. The evaluation was performed with patients supine and with the head in line with the trunk in a relaxed position. We asked patients to breathe normally and not to speak. Two areas on both sides of the neck were evaluated.

The first area was the sternal ending of the SCM on the lateral site of the cricoid cartilage. The second was the scalene medius midway between the mastoid process and the first rib. Three measurements of fascial and muscle thickness in the proximal, middle and distal portions of the transductor were recorded. The mean value of the three was filed for evaluation. The investigators performing the testing and ultrasound data analyses were blind to subjects' condition. All evaluations were performed without causing any compression over skin. To guarantee this, every recording was carried out with about 100 μm of gel between transductor and skin. The operator moved the transducer in the coronal plane until the thickest value of the muscle belly was found. At that point, the axis of the transducer was moved until the direction of the perimysium was parallel to the transducer and the two extremities of the belly in the monitor were thickest. This procedure allowed the operator to position the probe over the center of the belly. Lastly, an attempt was made to evaluate the single layers of dense (collagen fibers) and loose (adipose cells, glycosaminoglycan, hyaluronic acid) connective tissues which comprise the deep fasciae.

Clinical study

Twenty-eight patients with CNP but without concomitant neurological, rheumatologic or orthopedic syndromes were recruited (9 M, 19 F; range 27–52 years, mean age 37.5 years) over a period of three consecutive months. In the patients group 20 subjects had reported prevalent pain on the right side and only eight subjects had reported mostly pain on the left. X-rays of the cervical spine in the two axes or previous X-rays of the cervical region, taken not more than 3 months previously, were available. We excluded patients with severe spondylo-arthritis or severe decrease of the intraforaminal space. This clinical trial was performed in accordance with ethical standards on human experimentation and with the Helsinki Declaration of 1975, as revised in 1983. The investigation and use of patient data for research purposes were in accordance with the Declaration of the World Medical Association. Written informed consent was obtained as required. The studies

follow Good Clinical Practice. Ethics statement was not needed because non-invasive conventional treatments were used. Patients were informed about every single treatment modality and the modes of evaluation. They were recruited consecutively from two clinics of the Department of Physical Medicine and Rehabilitation, University of Padova, Italy. Each patient was given a consecutive number. All patients were evaluated by a physician, blind to the afferent group of the patient.

The first evaluation was a measure of the active and passive ROM of the neck in three planes of space, with a rest of 1 min between each measure. The evaluations were performed with a helmet system (Chinesport) with two goniometers (for sagittal and frontal planes) and a compass (for the horizontal plane). They were performed with patients in a sitting position with their back touching the back of the chair near the perpendicular position. Patients were asked to complete the Neck Pain Disability Questionnaire (NPDQ) and to evaluate pain on the VAS scale. These data were recorded at each evaluation.

The 28 patients were then divided into two groups: MEL (massage, electrotherapy and LASER) or FM (fascial manipulation) at random (even number group MEL; odd number group FM). At $t = 0$, there were no statistical differences between the data of the two groups, which were thus considered homogeneous. The FM group was submitted to three sessions of the FM technique for one week. The MEL group received a combination of three treatments: massage, interferential current, and laser. As systematic reviews indicated that therapeutic massage may be more effective when it is combined with exercise or other interventions [8], we chose to combine massage with the other two physical therapies. Evaluations at the end of treatment, at 3 and 6 months, were performed by the same original physician, who did not know which type(s) of treatment had been performed.

Interferential current

Pre-modulated interferential current therapy with four electrodes was used. The electrodes were placed round the upper trapezius muscle. A pair of electrodes with a current frequency of 4,000 Hz crossed another pair of electrodes with a current frequency of 4,090 Hz, to stimulate the target muscle. Treatment lasted 20 min once a day, five times a week for 2 weeks.

Laser pulsed mode

Recent research indicates that laser produces anti-inflammatory effects and contributes to pain relief [29]. The incidence of adverse effects is low and similar to that of the placebo, with no reports of serious events [3]. Laser irradiation was applied to an average of 20 points (range 18–21) in the neck. The pattern of treatment was a course of 10 treatments, administered daily, five times a week for 2 weeks. Visible (632.8 and 670.0 nm) and infrared (904 nm) wavelengths were used in pulsed wave mode. Energy delivered per point at 904 nm was 2.5 J, with an irradiation time of 240 s.

Massage

We selected a connective tissue release technique based on the works of Sherman et al. [31], which indicates that massage is safe and may have clinical benefits in cases of CNP, at least in the short term. In the systematic review of Bronfort et al. [8], therapeutic massage is considered to be effective treatment for CNP (neck pain lasting for more than 3 months). Three therapists with more than 5 years of experience performed the massage. Such a number of therapists were necessary in order to cover the increased number of treatments. Treatment was for 40 min once a day, five times a week for 2 weeks.

Fascial manipulation

Fascial Manipulation® is a manual therapy technique which the Italian physiotherapist Luigi Stecco [36, 37] developed to treat myofascial dysfunctions [13, 17, 25, 26, 33]. According to this technique, the deep fasciae are considered the target tissues, and treatment consists of highly focused deep massage. The treated points are usually far from the site of pain, because the therapist must move from the site of pain to the Center of Coordination (CC). These are key fascial areas in which tension produced by muscle fiber contractions converge [12]. The CCs are very close to the trigger points and to acupuncture points. Melzack et al. [23] provide evidence that trigger points in the neck coincide with the location of acupuncture points in 70–90 % of patients (e.g., BL10, GB 20, GB21 and Ah Shi points). The method involves an initial anamnesis and chronological documentation of musculoskeletal events. Therapists then use standardized, functional movement tests [36, 37] and palpation to ascertain the condition of related CCs. Deep friction, with elbows or knuckles, is applied over each small area (Fig. 1) for a few minutes to create localized hyperemia, in order to restore gliding between collagen fibers [6]. Treatments were performed by the same therapist with more than 5 years of experience. The number of points treated in each treatment is listed in Table 1. We treat between 5 and 10 points. ROM, pain levels and muscle recruitment are verified immediately after treatment of each CC [13], and treatment progresses according to the results obtained. Patients are treated for 45 min three times a week.

Statistical analysis

In order to detect a reduction in pain of 2 points on the VAS scale, which fits a two-sided 5 % significance level and a power of 80 %, a sample size of 10 patients per group is necessary. Therefore, in this study, the aim was to have about 13 participants in each treatment group.

Changes in the outcome parameters at the end of follow-up with respect to baseline values were tested for significance with the Wilcoxon test. The Mann–Whitney test was used to ascertain the existence of differences between groups regarding changes in time of all outcome variables. Spearman's rank correlation test was used to evaluate the relationship between clinical and imaging dates. For all comparisons, the null hypothesis, i.e., no differences exist between groups as regards treatment effects, was applied. Statistical significance was set at $P < 0.05$. All analyses were carried out with standard SPSS statistical software.

Results

Case controls

In the pre-clinical study, a statistical difference ($P < 0.05$) was found between healthy subjects and patients with CNP in all three planes of movement (Table 2). These results clearly indicated that patients with CNP presented stiffness.

In the control group, the deep fasciae were easy to evaluate by ultrasound in all regions analyzed. They appeared as linear hyper-echoic layers, but the sub-layer conformation of the deep fasciae could be clearly revealed in only two cases. The thickness of the SCM and scalene medius fasciae was recorded (Table 3). In patients, the ultrasonographic evaluation showed that the fasciae of the SCM (sternal head) appeared thicker (+0.075 cm) on both sides (Fig. 2a, b) and in the scalene medius muscle (Fig. 3a, b) on the right side (+0.175 cm). We found a thicker scalene medius on the left side (+0.08 cm). In almost all the ultrasound images, we were able to identify the sub-layers forming the deep fasciae, with at least two layers of dense connective tissue (white layers, mean value 0.053 cm) and one layer of loose connective tissue (black layer, mean value 0.036 cm). In five patients, three layers of dense connective tissue and two of loose connective tissue (LCT) were identified (Fig. 4a, b).

Groups: MEL and FM

The clinical study demonstrated that both groups, MEL and FM (Fig. 5a, b), had a decrease in pain (from a mean VAS value of 4.9–1.9), but the decrease was lower in the MEL

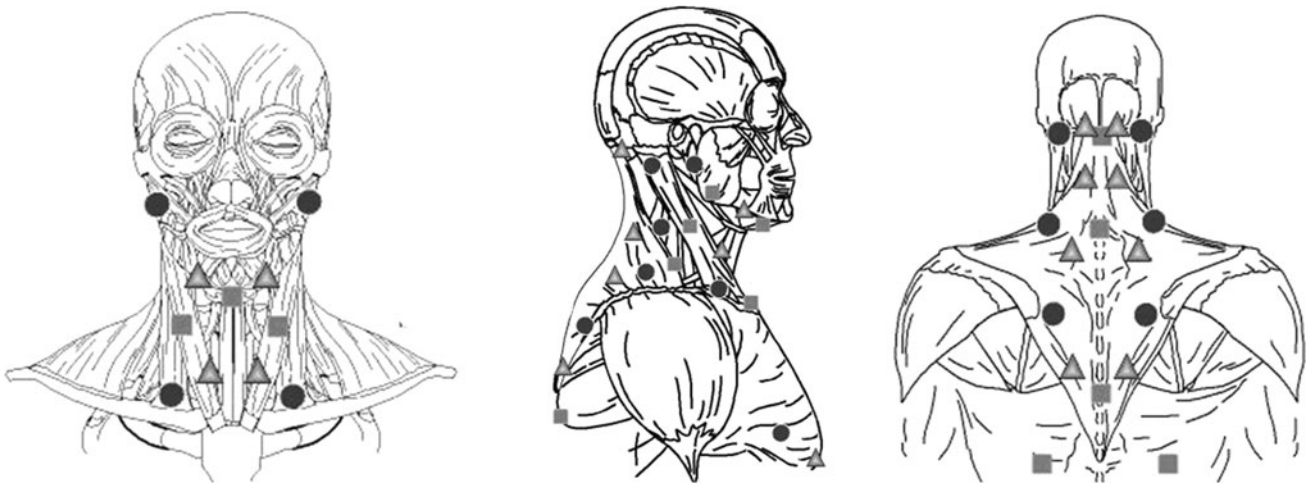

Fig. 1 Points of fascial manipulation technique. *Triangles*, *quadrants*, *circles* points correlated, respectively, with sagittal, frontal and horizontal planes of movement. In some of these points, therapist treated patient by digital pressure

Table 1 Number of points for treatment in FM group

Patients	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1st treatment	8	7	5	6	5	6	7	6	6	8	7	6	5	5
2nd treatment	6	6	5	6	10	6	10	5	7	8	8	8	10	8
3rd treatment	8	10	8	8	9	8	8	7	8	7	8	10	10	9

Table 2 Range of motion of patients and controls before treatment

Degree	Cases		Controls	
	Average	SD	Average	SD
Flexion				
Act	48.80	11.25	59.20	12.11
Pass	53.80	11.23	65.27	12.13
Extension				
Act	51.32	14.09	68.40	8.20
Pass	54.96	14.95	73.25	7.34
Lateral flexion				
Right				
Act	32.56	8.34	42.70	8.20
Pass	35.52	8.33	46.58	8.21
Left				
Act	31.60	8.41	46.60	10.30
Pass	34.52	8.36	50.91	10.35
Rotation				
Right				
Act	59.36	13.39	64.50	10.50
Pass	63.28	14.24	68.76	9.65
Left				
Act	63.24	15.01	69.30	7.11
Pass	67.36	15.34	73.81	6.78

Table 3 Thickness of various fasciae in patients and controls

	Controls		Cases		*P* value Mann–Whitney test	
	Left	Right	Left	Right	Left	Right
SCM sternal head						
Muscle belly						
Proximal	0.81	0.90	0.95	1.15	0.136	0.900
Middle	0.82	0.96	1.21	1.17	0.081	0.327
Distal	0.82	1.01	0.99	1.21	0.301	0.334
Fascia						
Superficial side	0.11	0.11	0.19	0.18	0.025*	0.035*
Deep side	0.12	0.11	0.16	0.11	0.066	0.282
Scalenus medius						
Muscle belly						
Proximal	0.63	0.72	0.92	0.88	0.014*	0.451
Middle	0.67	0.77	0.95	0.90	0.017*	0.603
Distal	0.62	0.78	0.96	0.94	0.020*	0.664
Fascia						
Superficial side	0.16	0.10	0.22	0.29	0.076	0.031*
Deep side	0.18	0.11	0.28	0.27	0.063	0.030*

Values in cm

*represents the statistically significant difference

group (from 5.2 to 2.5; in the FM group, pain decreased from 4.7 to 1.5). In addition, the results remained consistent in the FM group (mean values of 1.8 at 3 months and 1.7 at 6 months), while the MEL group demonstrated an increase in pain according to the VAS scale of 3.4 at 3 months and 3.3 at 6 months.

After treatment, the two groups also demonstrated varying results in ROM, at both 3 and 6 months after follow-up (Fig. 6a, b). In fact, the MEL group showed no improvement in ROM (Fig. 6b). Three values showed a statistical decrease in range (lateral flexion on the right active post-treatment and at 6 months, and passive post-treatment). The FM group showed improved ROM, both active and passive, in most of the planes of space (better in extension and lateral flexion, absent in flexion).

The ultrasonographic study demonstrated a decrease in the fasciae thickness in both groups (−0.013 cm in MEL; −0.028 cm in FM) and persisting at the 3-month follow-up (−0.033 cm in MEL; −0.035 cm in FM) and at 6 months (−0.037 cm in MEL; −0.031 cm in FM) (Table 4), with a statistically significant difference (Table 5) in most of the area, both at the end of treatment and at 3- and 6-month follow-up (Fig. 7a, b). Analysis of the thickness of the various sub-layers showed that the changes in fascial thickness correlated more with the decreased thickness of LCT (black layer) than with a reduction in fibrous sub-layers (white lines) (Fig. 8a, b). A statistically significant difference was found only in the thickness of the LCT in all evaluations (Table 6). Spearman's rank correlation coefficient was used to analyze the correlation between clinical and ultrasound results. When the mean value of fascial thickness and the VAS of all patients were correlated, a value of $r = 0.38$ was found (Fig. 9). However, when we correlated only patients with LCT higher than or equal to 0.05 cm, the coefficient became $r = 0.44$.

Discussion

The data from the pre-clinical study indicated a correlation between stiffness (decrease in ROM), increases in deep fasciae thickness and CNP. In particular, the value of 0.15 cm (the mean value of two standard deviations of controls) of the SCM fascia was considered as a cut-off value which allows the clinician to make a diagnosis of myofascial disease in a subject with CNP. The variation of thickness of the fascia correlated with the increase in quantity of the LCT (black layer) but not with dense connective tissue (white layers), and probably more specifically with hyaluronan (HA). HA is in fact the chief component of the extracellular matrix [14] and the most prominent. It is produced by special macrophage-like cells which resemble fibroblasts, and occur on the surface of the fasciae [19, 34]. Piehl-Aulin et al. [27] demonstrated retention of HA after exercise, but in all overuse syndromes, an increase in the quantity of HA probably occurs

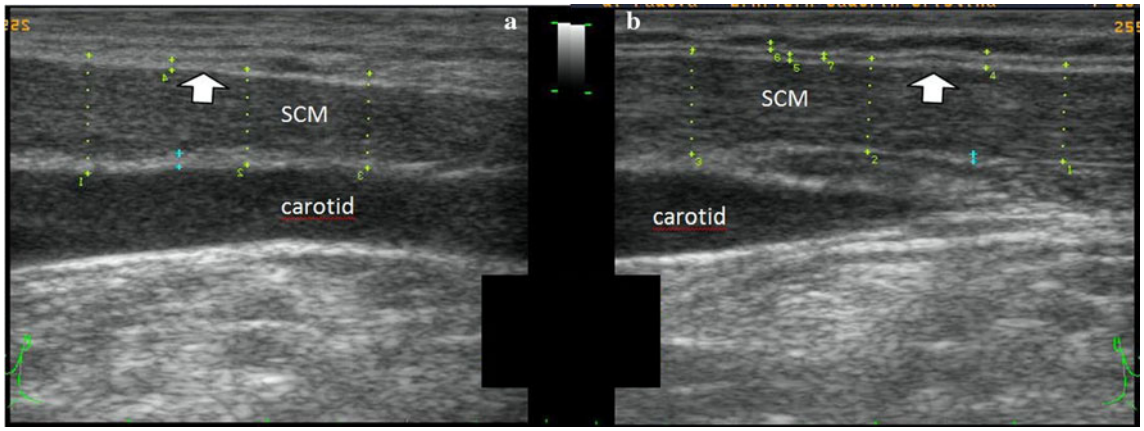

Fig. 2 **a** SCM in control subject (*arrow* fascia). **b** SCM in a patient (*arrow* fascia)

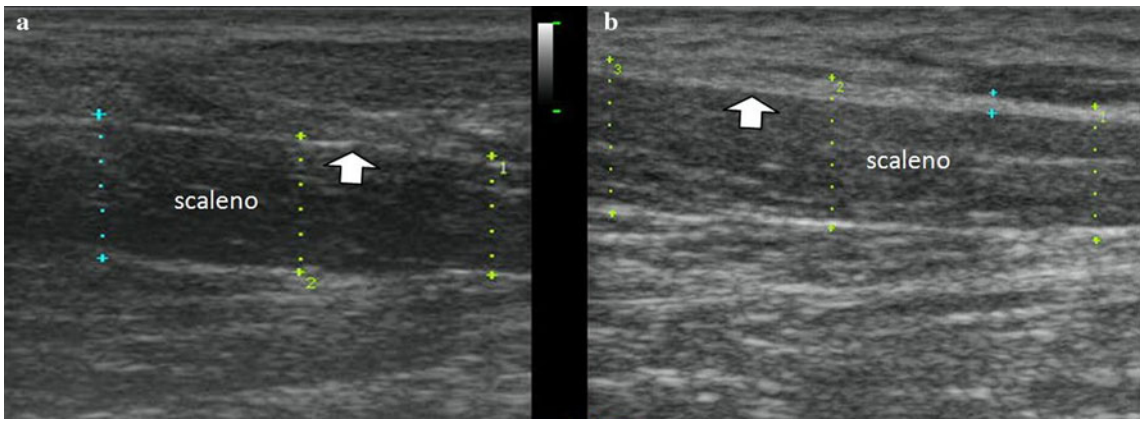

Fig. 3 **a** Scalene medius muscle in a control subject. **b** Scalene medius muscle in a patient

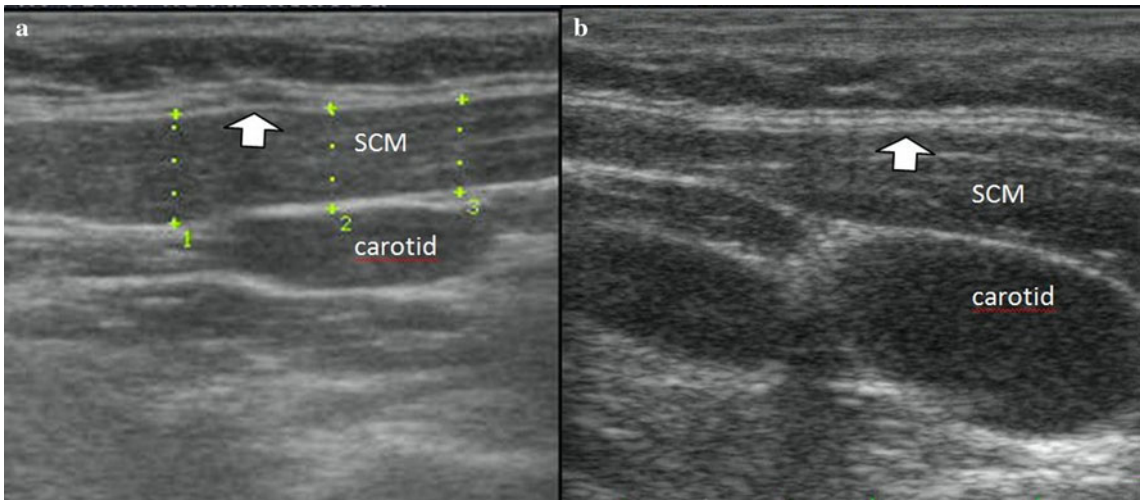

Fig. 4 **a**, **b** Three layers of DCT and two layers of LCT in SCM fascia in a patient

in and on the surface of fascia. This may explain our findings. It is well documented [22] that increased HA correlates not only with improved lubricating function, but also with increasing viscosity. Above all, it is organized on a surface. At high concentrations, HA behaves like a non-Newtonian fluid and becomes more viscous [20].

Matteini et al. [22] observed that, when HA concentration is increased, the HA chains begin to become

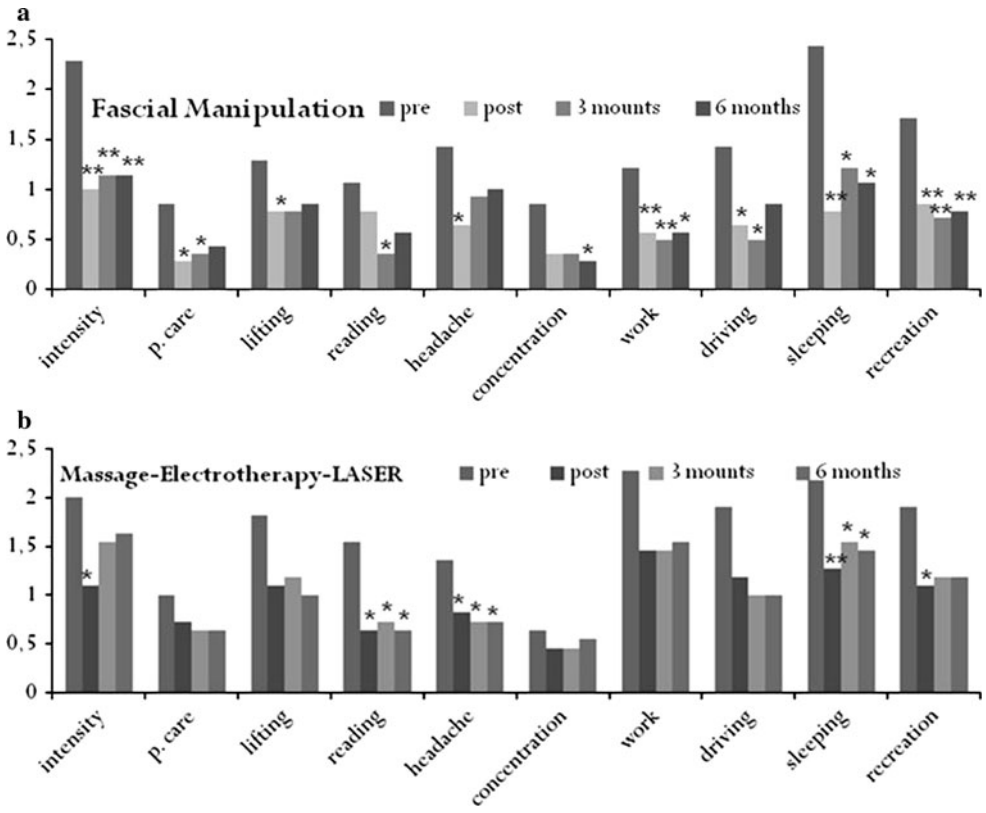

Fig. 5 **a** Results of NPDQ in FM group. **b** Results of NPDQ by MEL group (*P value <0.05; **P value <0.001)

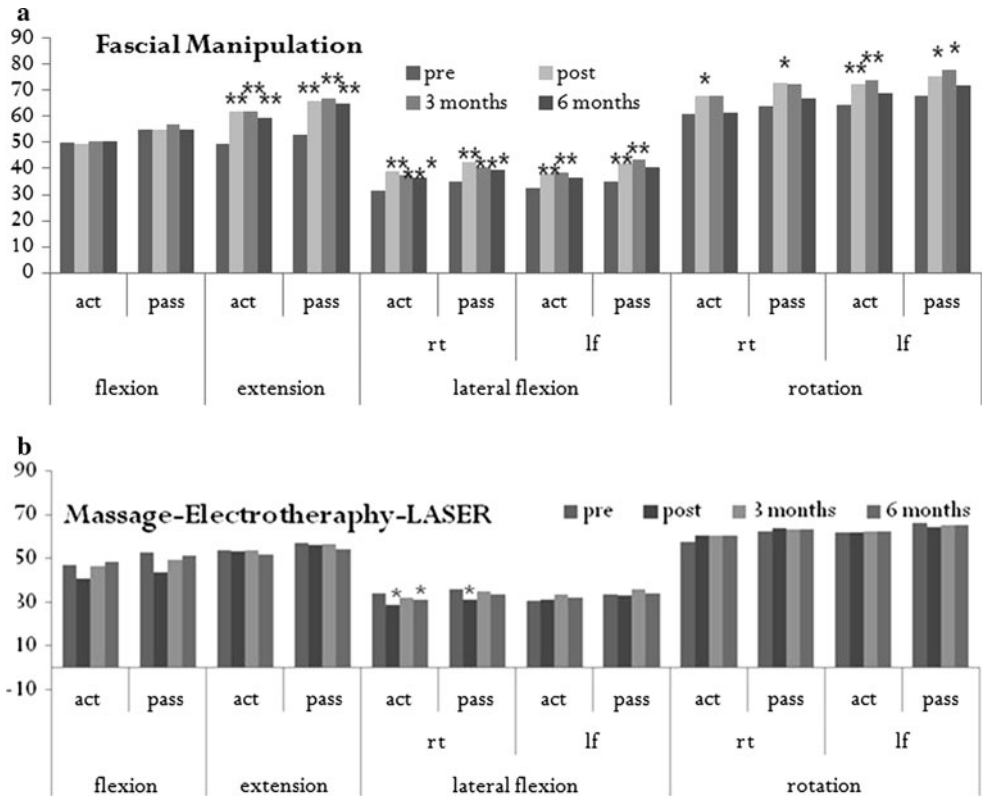

Fig. 6 **a** Active and passive ROM in FM group. **b** Active and passive ROM in MEL group (*P value <0.05; **P value <0.001)

Table 4 Mean fascial thickness in two groups

Side	Scm sx		Scalene sx		Scm dx		Scalene dx	
	sup	inf	sup	inf	sup	inf	sup	inf
Massage–electrotherapy–laser group								
Pre	0.149	0.110	0.101	0.116	0.154	0.112	0.117	0.135
Post	0.165	0.085	0.073	0.099	0.135	0.107	0.120	0.105
3 months	0.135	0.075	0.077	0.105	0.090	0.097	0.075	0.076
6 months	0.120	0.073	0.076	0.087	0.111	0.079	0.079	0.071
Fascial manipulation group								
Pre	0.163	0.107	0.098	0.096	0.148	0.115	0.119	0.126
Post	0.140	0.090	0.095	0.083	0.113	0.075	0.085	0.071
3 months	0.134	0.069	0.082	0.087	0.105	0.072	0.083	0.064
6 months	0.116	0.077	0.085	0.081	0.128	0.083	0.078	0.081

Values in cm

Table 5 Difference in thickness of deep fasciae in two groups in the four areas: *P* value between time zero and other evaluations

P value	Scm lf		Scalenus lf		Scm rt		Scalenus rt	
	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
MEL								
Post	0.2342	0.0004	<0.0001	0.3563	0.279	0.5329	0.0957	<0.0001
3 months	0.1778	0.0002	0.0002	0.0041	0.0114	0.3741	<0.0001	<0.0001
6 months	0.0166	0.001	0.0112	0.008	0.0098	0.001	<0.0001	<0.0001
FM								
Post	0.0216	0.0597	0.6396	0.0486	0.012	<0.0001	0.0032	<0.0001
3 months	0.0113	<0.0001	0.0145	0.1304	0.0013	0.001	0.0003	<0.0001
6 months	<0.0001	0.0001	0.1078	0.0275	0.0803	0.0001	<0.0001	<0.0001

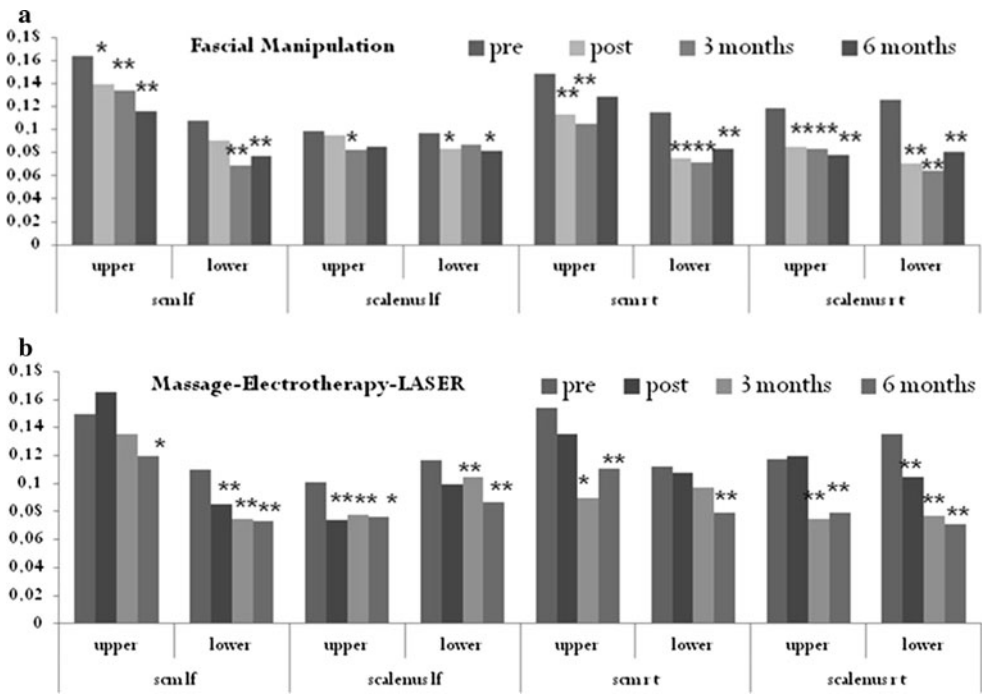

Fig. 7 **a** Mean thickness of deep fasciae in FM group. **b** Mean thickness of deep fasciae in MEL group (**P* value <0.05; ***P* value <0.001)

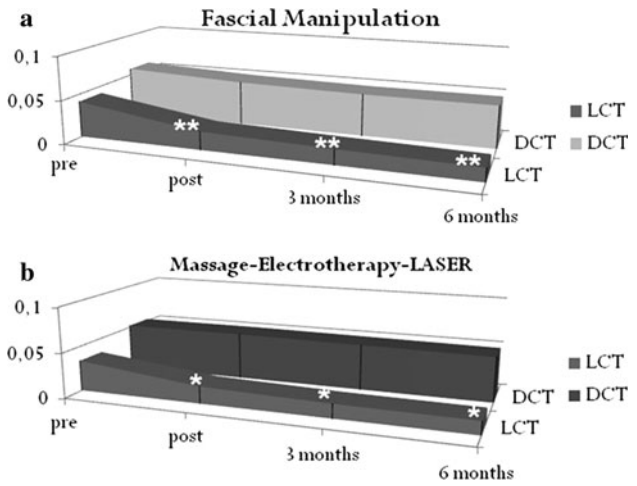

Fig. 8 **a** Mean thickness of loose and dense connective tissues in FM group. **b** Mean thickness of loose and dense connective tissues in MEL group (*P value <0.05; **P value <0.001)

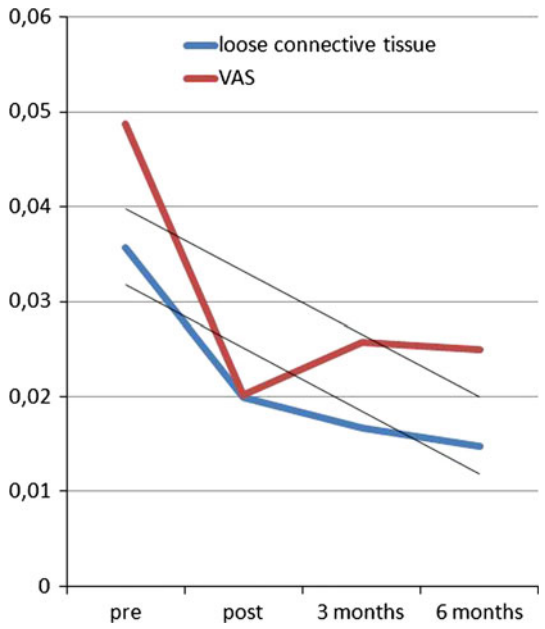

Fig. 9 Spearman's rank correlation test between thickness of loose connective tissue of deep fasciae and VAS

entangled, contributing to modify the hydrodynamic properties of the solution: viscoelasticity increases dramatically. Tadmor et al. [38] showed that viscosity increases considerably with increasing distance between the two surfaces. This reaction may explain the decrease in gliding action between the fibrous layers. The increased viscosity of the LCT inside the fascia may cause decreased gliding between the layers of collagen fibers of the deep fasciae and this may be perceived by patients as stiffness. In addition, several authors [2, 11] have documented the viscoelastic shape of the dynamic response of mechanoreceptors. The deep fasciae are well known [35, 39, 40] to be well innervated, mainly with free nerve endings and proprioceptors. We postulate that increased viscosity alters the dynamic response of these fascial mechanoreceptors, causing pain and alteration in proprioception.

The results of our treatment may be explained thanks to the research of some investigators [22, 30], who show that the three-dimensional superstructure of HA chains breaks down progressively when temperature is increased to over ~40 °C. This may explain why laser works in this syndrome. Increased temperature does break down the superstructures, with a consequent decrease in viscosity. Manual treatment is also effective in heating the LCT inside the deep fascia. Massage and fascial manipulation are nothing more than pressure with friction within the subcutis layer. For this reason, we presume that these manual treatments raise the temperature in the subcutis and deep fasciae. The therapeutic result of both types of treatment is probably due to the fact that HA shows non-Newtonian flow characteristics. The viscosity coefficient is not a constant, and the fluid is not linearly viscous: viscosity decreases and the fluid thins over a period of continued stress. Chytil and Pekar [9] demonstrate that, at low shear stress levels, chains of high molecular size HA (10^6–10^7 Da) are efficient in re-associating in their previous superstructure after the load has been removed. However, too high a shear leads to irreversible disruption of the structure. We postulate that massage represents low shear stress, whereas fascial manipulation is similar to high shear. For this reason, our MEL group did not show the same long-term results as the FM group. This may indicate that the initial improvement in a decrease in fascial thickness is a decrease in pain. However, if the clinician can reduce the thickness to a value similar to that of normal subjects, patients will achieve better active and passive ROM.

Table 6 Difference in thickness between the evaluation at: time zero, post-treatment 3 and 6 months

	Post			3 months			6 months		
	LCT	DCT	P value LCT	LCT	DCT	P value LCT	LCT	DCT	P value LCT
elm	0.0424	1	0.0424	0.0415	0.6811	0.0415	0.0277	0.5121	0.0277
fm	0.0018	0.5035	0.0018	0.0044	0.2691	0.0044	0.0067	0.4068	0.0067

Values in cm

The patients in both groups reported decreased pain and a better quality of life at the end of treatment, and most of the results were confirmed at 3- and 6-month follow-up. The FM group had better and more sustained improvement at both follow-ups, reporting lower VAS levels. Decreased fascial thickness was found in both groups, but in the FM group it was higher and remained higher at follow-up. This result is well correlated with the better results found in FM group, referring to the VAS scale and active and passive ROM. We assume that the lower value of fascial thickness correlates with decreased symptoms. If the thickness value becomes similar to that of normal subjects, we also have restoration of active and passive ROM. In fact, both groups reported decreased pain and had better scores on the NPDQ, but only the FM group, which had a greater decrease in fascial thickness, also had an increase in ROM. These results support the validity of fascial manipulation in restoring fascial physiology. In addition, the cost of the two types of treatments differed greatly. In the FM group, each patient required a total of 135 min of individual treatment. In the MEL group, patients had 400 min of individual treatment, plus 200 min of electrotherapy and 100 min of laser, i.e., more expensive in comparison at FM group. Operators with skill in fascial manipulation may be able further to decrease the costs of both treatment and times.

Limitations of the study

The MEL group was treated by one therapist for laser, one for electrotherapy and three for massage, due to the high number of treatments required. For this reason, the study had high inter-operator variation.

The dimension of the ultrasonographic evaluation was at the limit of the machine. Values below 50 μm are considered not possible for machine identification. Conversely, the quality of ultrasound machines is improving every year, as is the capacity of the software to identify the diffractive border. Examples are the new types of software which can evaluate intimae media thickness at ±0.004 cm (SD 0.10) machine error [7].

Two patients in the MEL group dropped out after treatment, expressing no satisfaction following treatment. These dropouts decreased the number of dates in the observation period.

Conclusions

This study highlights for the first time alterations of the deep fasciae of the neck in patients with CNP and demonstrates that physiotherapy can modify fascial thickness.

Ultrasound is now considered a reliable method for visualizing fasciae and facilitating the diagnosis of myofascial pain. In particular, this research indicates that the deep neck fascia thicker than 0.15 cm overall (more than 2 standard deviations of controls) may help to make correct diagnoses of myofascial pain or non-specific pain.

Ultrasound indicates that the main alteration in the deep fasciae is increased loose connective tissue between the fibrous sub-layers. It is for this reason that, in indicating fascial alteration, we do not use the term “fibrosis”, which indicates an increase in collagen fiber bundles. We prefer the term “densification”, which suggests a variation in the viscosity of the fascia.

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Conflict of interest The authors declare that they have no conflict of interest. The Department of Physical Medicine and Rehabilitation provided all equipment for the project. There are no financial benefits to the authors.

Ethical standard This clinical trial was performed in accordance with ethical standards on human experimentation and with the Helsinki Declaration of 1975, as revised in 1983. The investigation and use of patient data for research purposes were in accordance with the Declaration of the World Medical Association. Written informed consent was obtained as required. The studies follow Good Clinical Practice. Ethics statement was not needed because it was used non-invasive conventional treatments. Patients were informed about every single treatment modality and the modes of evaluation.

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