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CASE REPORT

Impact of massage therapy in the treatment of linked pathologies: Scoliosis, costovertebral dysfunction, and thoracic outlet syndrome

Michael Hamm, LMP

1729 12th Avenue, Apartment 208, Seattle, WA 98122, USA

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Thoracic outlet syndrome;
Chronic pain

Summary
Objectives: To investigate the efficacy of massage therapy in the concurrent treatment of three related, but discrete, disorders: scoliosis, costovertebral dysfunction, and thoracic outlet syndrome.
Methods: A 34-year-old female subject reported steadily increasing pain in the right shoulder over the previous 8 months. Chiropractic diagnosis and assessment by the author's clinical supervisor had identified these three conditions. Massage therapy was administered twice weekly for a total of 8 sessions. Each 75-min session included 15 min of intake and assessment, during which pain levels (PLs), sleep patterns, and functional limitations were recorded. Treatment was applied in the remaining 60 min, and consisted of Deep Tissue, Neuromuscular, and Muscle Energy techniques. The clinical supervisor conducted three extended assessments, which were performed prior to, halfway through, and after the treatment series.
Results: Reported PLs, sleep patterns, and functional limitations all showed substantial improvements over the course of treatment, despite a re-injury to the affected shoulder before the seventh session. Assessment by the Clinical Supervisor confirmed these results.
Conclusions: Massage therapy is an appropriate tool for the concurrent treatment of these three conditions. Further research should focus on the ability of massage to address pathologies normally dealt with as separate entities.

Introduction

The author sought to design an integrative treatment protocol that closely mirrors massage therapy as practiced, and to suggest that functional linkages among these conditions may improve their recovery in concurrent treatment. Those functional linkages, described below, were only used to justify the inclusion of all three conditions in the study and to interpret the results. No attempt was made to

E-mail address: mike.hamm@gmail.com.

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use unconventional manual therapy: each individual technique or modality was selected for its documented effect on a specific structure. Moreover, each condition was separately evaluated based on its own symptomatology. A literature review was used to show three features for each condition:

(1) etiology and conventional treatments,
(2) justification for the use of massage therapy, and
(3) evidence for functional linkages to the other two conditions.

Scoliosis

Scoliosis is simply defined as a lateral curvature (Soderberg, 1997) of the spine, often coupled with a rotational component (Werner, 2002a). Specific causes can be structural or functional (Soderberg, 1997; Werner, 2002a), but unless the curvature is severe, many scolioses are asymptomatic (Hertling and Kessler, 1990d). When medical intervention is deemed necessary, conventional attempts to prevent or treat the abnormality do not meet with consistent success. Furthermore, several of the treatments, such as external braces or surgically implanted rods, present significant disadvantages of their own (Soderberg, 1997). Manual therapy has been used with some benefit (Shea, 2000; Hawes and Brooks, 2002) in treating scoliosis. This is achieved by removing myofascial restrictions (Werner, 2002a) that create uneven axial loads (Soderberg, 1997) on the spine, and by re-training habitual movement patterns (Werner, 2002a; Shea, 2000) that perpetuate postural deviation. In addition to its own localized pathological effects, scoliosis can also be a fertile background for the evolution of adaptive dysfunctional problems. For example, the lateral flexion of a scoliotic vertebra immediately limits its ability to move in flexion-extension or rotation (Mitchell and Mitchell, 2002a, p. 33; Dvorak and Dvorak, 1990a, pp. 24–25). Limited range of motion (ROM) in vertebral rotation can, in turn, translate abnormal stresses into the costovertebral joints (Mitchell and Mitchell, 2002a; Dvorak and Dvorak, 1990a) (see Figs. 1 and 2), predisposing them to articular dysfunction. Scoliosis is also linked to thoracic outlet entrapment, through its ability to create myofascial trigger points (TrPs) and/or fibrotic contracture in the scalene muscles of the neck (Simons et al., 1999b; Sanders et al., 1990). The scalenes are the most common entrapment site in thoracic outlet syndrome (TOS)

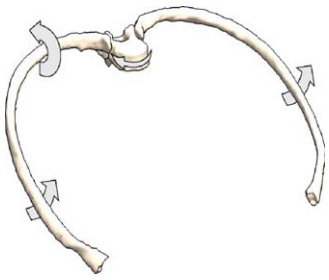

Figure 1 Rib torsion secondary to vertebral rotation (original and updated version by Lincoln Ritter and Wilmot Wei-mau Li, 2005).

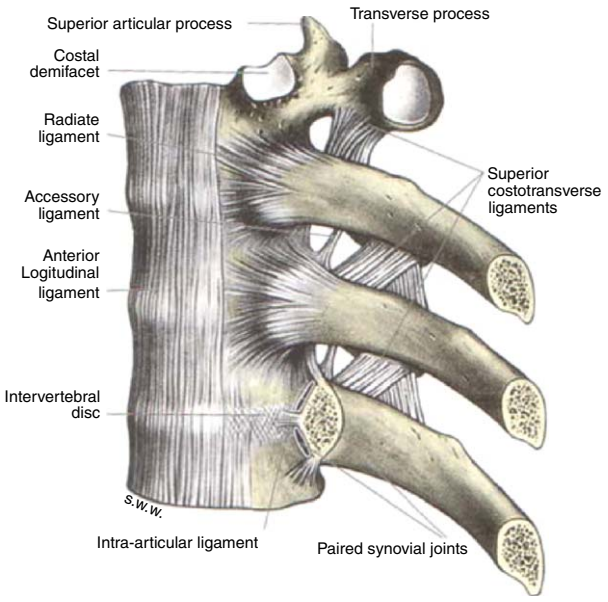

Figure 2 Costovertebral joints (Standring, 2005, p. 959).

(Simons et al., 1999b; Cailliet, 1991; Sanders et al., 1990).

Costovertebral dysfunction

The rib cage is an intricate structure with close functional linkages to the spine and shoulder complex (Soderberg, 1997; Hertling and Kessler, 1990b; Dvorak and Dvorak, 1990b). Lesions involving the articulations of the ribs with the thoracic spine can be caused by minor trauma or, as discussed, vertebral segmental dysfunction (Mitchell and Mitchell, 2002c). Mitchell and Mitchell describe the successful evaluation and treatment of rib lesions using manual therapy—specifically, a class of facilitated soft-tissue mobilization methods known as muscle energy technique (MET). There are two primary ways in which costovertebral dysfunction is related to TOS entrapment: one is through the normal motions of the shoulder

complex—the ribs and shoulder form a "closed kinetic chain" (Hertling and Kessler, 1990a). A restriction in one structure invariably demands increased movement from the other. Thus, the shoulder complex can become overtaxed by costovertebral immobility. Secondly, the ribs play a central role in breathing, and a primary mover during inspiration is the scalene group (Hertling and Kessler, 1990b; Simons et al., 1999b; Edgelow, 1997; Perri and Halford, 2004; Legrand et al., 2003). Once again, restriction in the ribs can demand more effort from (and so potentially injuring) related structures.

Thoracic outlet syndrome (TOS)

This condition describes a number of symptoms related to neurovascular entrapment in the thoracic outlet (Werner, 2002b; Edgelow, 1997) (see Fig. 3). These symptoms include edema, motor loss, numbness, tingling, and shooting or aching pain down the affected arm (often to the ulnar half of the hand) (Werner, 2002b; Simons et al., 1999c; Cailliet, 1991; Edgelow, 1997).

The most common symptoms arise from the compression of the brachial plexus at several possible sites due to osseous abnormalities, traumatic injuries to the neck and shoulder, and various non-traumatic etiologies (Brantigan and Roos, 2004b; Sanders et al., 1990; Simons et al., 1999f). TOS is found more frequently in women (Brantigan and Roos, 2004a; Sanders et al., 1990).

The highly variable nature of both the symptoms experienced and the entrapment sites (let alone the causes of those entrapments), has made the definitive diagnosis of TOS very difficult (Simons et al., 1999c; Cailliet, 1991; Edgelow, 1997; Lowe, 2004; Brantigan and Roos, 2004a).

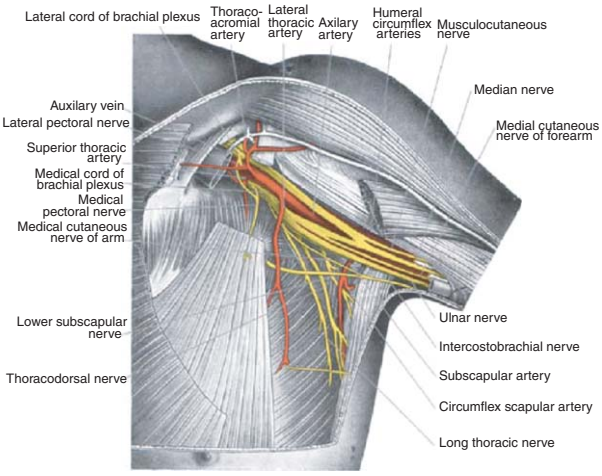

Figure 3 Thoracic outlet and related structures (Standring, 2005, p. 841).

Surgery to relieve compression yields mixed results (Simons et al., 1999c; Lindgren, 1997) with occasionally debilitating outcomes. Conservative medical treatment focuses on reducing shoulder protraction/medial rotation, freeing myofascial restrictions, reducing emotional stress, and strengthening supportive musculature (Edgelow, 1997; Lindgren, 1997; Cobb and Cantu, 1997).

Massage therapy, in this case, has identical aims to conservative medical treatment, and employs many similar techniques (Cailliet, 1991; Lowe, 2004; Cobb and Cantu, 1997). One important caveat for the diagnosis of TOS is that active myofascial TrPs in the shoulder can sometimes closely mimic the compression symptoms, resulting in a "pseudo"-TOS (Simons et al., 1999a, c, d, e; Huang and Zager, 1990). To make things even more complex, this "myofascial variant" on TOS can itself cause secondary true-entrapment TOS through muscular contracture from active TrPs (Simons et al., 1999a, c). The author of this study, recognizing both the non-definitive etiologies of TOS and the non-definitive symptomatology of the subject client, chose to employ techniques expected to effect positive change in both true-compression TOS and pseudo-TOS (see below).

The treatment techniques and principles employed in this study were applied according either to cited sources or to the curriculum of the massage school the author is attending. METs (Mitchell and Mitchell, 1999a; Chaitow, 1987b) use the subject's muscle engagement against the practitioner's firm resistance to effect changes in structural muscle balance. The documented efficacy of MET and related techniques (e.g. proprioceptive neuromuscular facilitation or PNF) was commonly attributed to a post-isometric relaxation response mediated by the Golgi tendon organs (Spernoga et al., 2001), but more recent studies suggest that it is due to the alteration of "stretch perception". (Magnusson et al., 1996a, b; Chalmers, 2004; Taylor et al., 1990).

MET is also used in the treatment of myofascial TrPs, and is well-suited to concurrent use with neuromuscular therapy (NMT) (Chaitow, 1987b). This study used MET maneuvers to relax paraspinal contractures in treating scoliosis and to improve costovertebral articulations. NMT was employed for its documented utility both in effecting general relaxation and in the release of active TrPs (Simons et al., 1999c; Chaitow, 1987a). Standard passive stretching of shortened muscles and myofascia (Cobb and Cantu, 1997) was also used to improve

tissue mobility and circulation in the thoracic outlet. Musculotendinous soft tissue changes in the scalenes and infraspinatus muscles were discovered during the treatment series, and Cyriax-style cross-fiber friction (XFF) followed by ice massage was applied subsequently to those areas of dysfunction (Werner, 2002a).

Special attention was paid to finding a good range of quantitative and qualitative indicators for progress, and whenever possible, a quantitative measure was used:

1. Pain level (PL) was quantified on a scale of 0–10, with the scale tied to ability to perform daily tasks. PL was recorded before, immediately after, and 3 h after a treatment session. Pain was also quantified in time: the subject is a massage student herself, and she recorded pain onset time and time of duration while performing a standardized, twice-weekly Swedish massage.
2. It was also important to measure sleep, since sleep disturbances are frequent in both TOS variants (Simons et al., 1999c). Sleep was measured in hours per night, and the patient was asked to comment on changes in the quality of her sleep.
3. The final numbers-based measure was not rigorously quantitative: the author estimated the left–right difference in standing iliac crest heights by resting his thumbs horizontally on the apex of each iliac crest (Mitchell and Mitchell, 1999c). Given the lack of equipment for precisely measuring scoliotic curves and the prior involvement of pelvic distortion in this patient's scoliosis (as identified by the clinical supervisor), a running comparison of iliac crest heights was deemed an acceptable indirect indicator for lumbar scoliosis in this patient. The height discrepancy was estimated in centimeters (cm) and recorded before and after a corresponding MET correction for lateral lumbar spinal curvature.
4. All other measures, which included shoulder-ROM tests and visual assessments of before/after thoracic curvature, were qualitative. The data from these, while certainly valuable, were chiefly meant to enrich the conclusions drawn from the quantitative measures.

Methods

Client profile

A 34-year-old female waitress and massage student began to experience pain and intermittent weakness in her right shoulder/arm 8 months prior to study. Symptoms began without disturbing day-to-day functionality, but soon required modification, and finally cessation, of her job as a waitress. Four months prior to the study, symptoms persisted night and day. The subject woke up between 5 and 8 times per night and total sleep time steadily decreased. Her job was an increasing source of stress, and involved repetitive movements of the afflicted arm through high-impingement ROMs (carrying heavy trays, reaching for boxes on high shelves—see Brantigan and Roos, 2004a). Job functionality and sleep were maintained through NSAID medication (1 *Aleve* before work, 1 *Aleve* before bed) but pain reduction did not last, and the subject was forced to quit her job 3 weeks before the study. Procaine injections along the hood of the right trapezius 2 weeks prior also proved ineffective. Twelve chiropractic sessions spanning from 3 months to 1-month prior did little to alleviate the problem. From final assessment and X-ray films, the chiropractor diagnosed costovertebral joint dysfunction, TOS, and scoliosis. He also noted weakness in the external rotators of the affected shoulder. He recommended rotator cuff strengthening exercises and self-stretching to combat the offending shoulder pain. Initial assessment, performed by the clinical supervisor, concurred with all of these diagnoses. Articular misalignment was found in the right-side ribs 2, 4, 5, and 7, with possible elevation of the first rib. The clinical supervisor also noted anterior shoulder pain during resisted medial rotation, pain referring up the neck during resisted biceps/humeral flexion test, and pain/slightly decreased ROM in passive shoulder elevation. The right posterior thorax was more tender during palpation (Hertling and Kessler, 1990c), and the right shoulder was protracted and medially rotated in comparison to the left (this is a characteristic posture for TOS) (Edgelow, 1997). The lumbar scoliosis was concave to the left, with the thoracic curve concave to the right, and a crossover around the T10–T12 vertebrae. The subject was unable to sleep more than 5 h per night, and was unable to give Swedish massage without immediate onset of prohibitive pain.

Assessment by the author confirmed all of the above. Since the existence of proximal referred pain is strongly suggestive of myofascial TrPs, it was considered possible that all reported TOS symptoms could instead be due to "pseudo"-TOS (Simons et al., 1999a, c) combined with a more conventional repetitive strain injury to the rotator cuff (Edgelow, 1997). The only expected caution for treatment was direct pressure on the entrapped neurovascular bundle (Werner, 2002b). The subject

has a history of chronic respiratory infection and chronic cystitis; the latter was being treated with homeopathic medications Berberis and Belladonna. No other drugs were being taken. The subject desired, at the end of this treatment series, to be able to perform a 1-h Swedish massage without modification of strokes, and with post-massage pain duration of less than 15 min. She also hoped to average 7+ hours of sleep per night.

Treatment plan

The objective of the treatment plan was to deliver the subject's desired outcome, as stated above. Based on documented linkages among the three highlighted conditions, and based on the documented applicability of manual therapy for each, it was expected that a concurrent treatment of all three conditions would yield favorable results for each. The plan employed four different techniques—MET, NMT, passive myofascial stretching, and XFF—whose efficacy and application to each of the identified dysfunctional patterns were described above. The applicability and rationale for the type of data collected was also explained earlier.

The numerical pain level (PL) [0–10] was calibrated for functionality in performing normal daily activities, such as driving a car:

- Zero [0] indicated no pain.
- Range [1–3] indicated pain that did not require activity-modification.
- Range [4–6] indicated pain that *did* require some modification to complete tasks.
- Range [7–10] indicated pain that fully prohibited one or more activities.

Treatment spanned 8 sessions over 4 weeks. Each session was divided into five 15-min segments, as follows:

Segment 1: Segment 1 consisted of intake and assessment. The subject was asked to report PLs immediately after, and 3 h after the previous treatment, the PL on the day, number of hours of sleep after the last session and before that day's session, as well as pain onset/duration time while giving a standardized 60-min Swedish massage (see Figs. 6 and 7). The subject was also asked to report any aggravating activities between sessions.

Lumbar scoliosis was indirectly assessed with an iliac crest height-discrepancy test (Mitchell and Mitchell, 1999c), and qualitative notes were made on spinal curve, restrictions in shoulder ROM, and tenderness in rib joint palpation.

Segment 2: Segment 2 consisted of MET. The subject contracted shortened muscle groups against resistance 5–7 times for 6 s each, moving into a new end-range after each contraction. The first muscles addressed were the quadratus lumborum and the paraspinals on the left (concave) side of the lumbar spine (Mitchell and Mitchell, 1999b,d). Ilium height was re-tested. The right-side thoracic paraspinals were similarly lengthened, and then re-assessed qualitatively.

Segment 3: Segment 3 consisted of supine NMT and myofascial stretching of the pectorals and subscapularis—both potentially associated with TOS (Simons et al., 1999a, c; Cailliet, 1991). Discovery of active TrPs was documented.

Segment 4: Segment 4 used the same techniques on the posterolateral neck, paying special attention to the scalenes and levator scapulae, also because of their TOS-implications (Simons et al., 1999a, c). TrPs were documented once again.

Segment 5: Segment 5 consisted of prone NMT on the posterior rotator cuff, the scoliosis-shortened paraspinals and quadratus lumborum, and the rib-connected iliocostalis. The massage ended with a final MET correction, wherein thumb pressure was applied inferiorly to the superior aspect of the medial posterior ribs 1, 2, 4, 5, and 7 on the right side, as the subject took slow, deep breaths (Schneider et al., 1988; Mitchell and Mitchell, 2002b, c). If any change in the resting position of the costovertebral joint was felt, it was documented.

Summary of visits

The subject, having attempted multiple failed treatment methods, reported some apprehension at the start of the study. As expected, certain symptoms responded immediately to treatment while others only gradually improved. However, the short-term impact of each treatment on sleep and PL greatly reduced reported emotional stress, and convinced the subject that some long-term relief was possible. After seeing sustained improvement following the fourth session, the subject began attempting ambitious new physical activities, such as rock-climbing (2–3 h per week). Unfortunately, the subject re-aggravated her shoulder while practicing Yoga on the day before the seventh session, and symptoms increased for the last two sessions. Active TrPs were located and treated in the iliocostalis, scalenus medius, subscapularis, and pectoralis minor muscles. Muscle palpation elicited the greatest pain around the right-side C6 middle scalene attachment, which

was warm and slightly edematous. Gentle cross fiber friction followed with ice massage reduced pain and edema until, in the eighth session, the area had normalized.

Results

Each treatment effected an immediate reduction in PLs, although sessions 1 and 7 (at the beginning of the series and after the re-injury) saw PLs rise above pre-treatment level after 3 h (see Fig. 6). At the beginning of the series, the subject's attempts to perform a standardized 60-min Swedish massage caused immediate prohibitive pain that lasted for the rest of the day (see Fig. 7). Gradual improvement in both PLs and duration was seen during the course of treatment until the re-injury. On the day before the injury, the subject performed her massage for 45 min without pain onset and felt noticeable pain for only 120 min afterward.

Before the series, the subject averaged between 4 and 5 h of sleep per night. Sleep duration showed immediate and sustained improvement, peaking at 8 h—once again, before the re-injury (see Fig. 4). The patient also experienced substantial improvements in the quality of her sleep: by the third session, she reported waking only 3–4 times per night, as opposed to 5–8 times per night before the beginning of the series. By the end of the series, she averaged 2–3 instances of waking per night, and this figure remained stable despite the re-injury. In addition, she reported a positive change in her ability to fall asleep, starting before session 4 and once again remaining relatively stable through the series' end.

The most noticeable changes were seen in the iliac crest height discrepancy, which responded immediately to each MET treatment, as described above. The improvement was not fully maintained between treatment sessions. The first session resulted in a change from 1. The 5 cm (one and a half cm) discrepancy, to less than 0.25 cm (one-quarter cm) and the second session (with the discrepancy back up at 0.5 cm/half-cm) produced no discernible change. Less response was seen over sessions 3–5, but every treatment thereafter reduced the discrepancy to zero, and it was not exacerbated by the re-injury (see Fig. 5).

Qualitative assessment by the clinical supervisor and the author showed gradual, but substantial, improvements in shoulder ROM (especially in lateral rotation) and in pain from tender spots (costovertebral articulations, scalenes, infraspinatus, teres minor). During the final assessment by the Clinical Supervisor (performed 1 week after the eighth treatment), mild posterior shoulder pain still persisted during resisted lateral rotation, abduction and flexion; the subject reported it as less than 50% of what she experienced before the study.

Postural indicators were mixed. Ilium height discrepancy was indiscernible to the clinical supervisor upon final assessment. The clinical supervisor noted that the scoliotic curve seemed somewhat improved, but precise measurement tools were not available to confirm this observation. The right shoulder was still noticeably protracted and medially rotated. The client reported that PLs and sleep patterns had almost returned to the levels she experienced before the re-injury, which took place 14 days before the final assessment.

Comment

This course of treatment yielded substantial improvements in almost every measured category. The most acute symptoms (shoulder/costovertebral

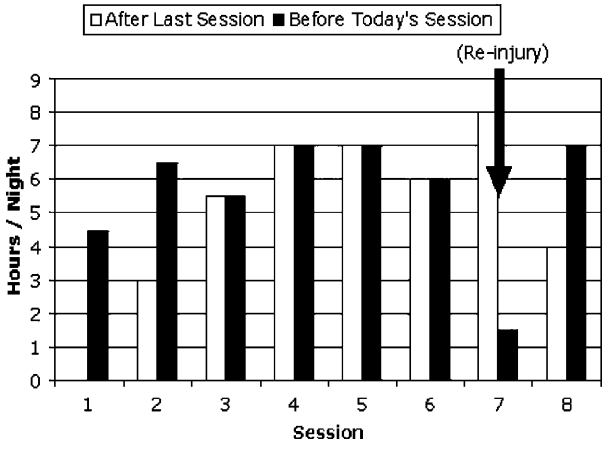

Figure 4 Hours of sleep between sessions.

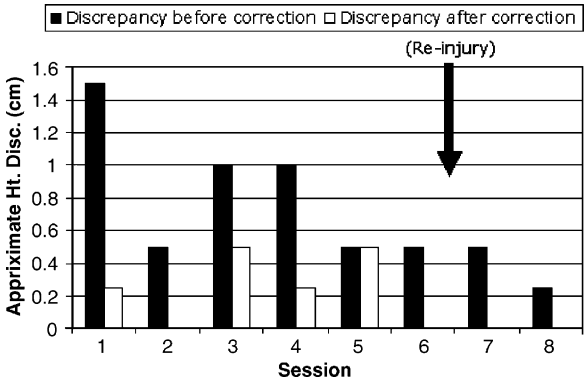

Figure 5 Iliac crest height discrepancy, before and after MET correction.

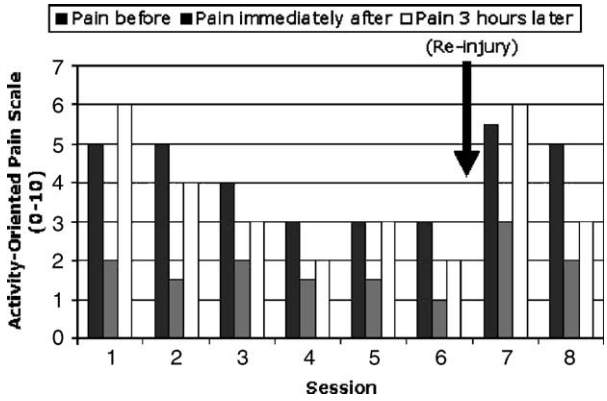

Figure 6 Pain level before and after treatment.

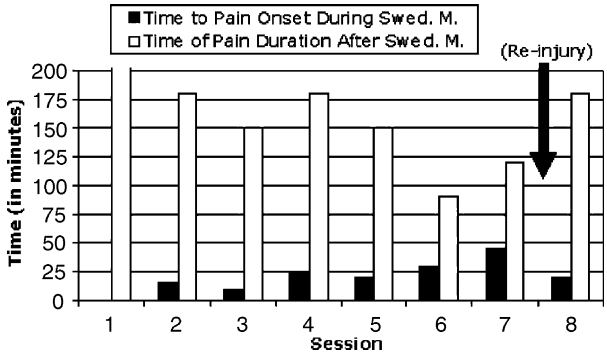

Figure 7 Time of pain onset and duration for client's Swedish massage practice.

pain and lack of sleep) dissipated most readily, while longstanding postural habits—with the exception of iliac crest height—responded less dramatically. This was to be expected: Moyer et al. suggest that the therapeutic effects of massage can be divided into "single-dose" and "multiple-dose" effects (Moyer et al., 2004). While acute pain and sleep are often improved with just a single dose, more persistent dysfunctional patterns only show discernible improvement from the compound effects of several sessions. Though initially considered detrimental to this study, the subject's re-injury prior to the seventh session yielded some interesting information: although PLs, hours of sleep, and daily functionality all worsened directly after the injury, these symptoms also subsequently improved more rapidly than during their initial treatment. This suggests that the treatment series improved not only the symptoms themselves, but also the body's ability to recover from acute relapses. Unfortunately, there was not sufficient time after the study to test for long-term effects, which often show major advantages of massage over other treatment options (Moyer et al., 2004).

A larger-scale study of massage therapy in the concurrent treatment of these conditions would benefit from several modifications in the present design. Most importantly, the application of precise measures for bony alignment would greatly strengthen any positive findings on massage therapy's ability to effect structural change. A standardized measure for psychological stress would also yield valuable data on a common and oft-ignored dimension in musculoskeletal dysfunction.

A major aim of this study was to closely mirror massage therapy as it is actually practiced. The author accordingly decided to treat the subject as a whole person (Edgelow, 1997), and this decision demanded that the subject's patterns of dysfunction not be divorced from one another. The risk with such an approach is that individual results cannot always be assigned to one or another causative mechanism. And since this study dealt with only one individual, it cannot be known whether a conventional approach would have yielded different results. However, Suprina suggests that using an integration model is highly preferable in the treatment of chronic pain (Suprina, 2003). In applying such an integrative paradigm, the author suggests that the most effective treatment series involves concurrently treating linked diseases in the hopes of more easily unraveling the chronic parent dysfunction. Massage's potential for simultaneous beneficial influence on multiple systems and processes in the treatment of pain and dysfunction would be a fruitful subject for future research.

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